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EDITORIAL NOTES—GAS, &c.

The Meeting of the Institution.

MANY impressions crowd upon one when thinking over the events of last week's meeting of the Institution. Foremost, the President (Mr. Thomas Glover) has won fresh laurels, not only as an earnest student of the affairs of the industry, but for the ability he displayed in the conduct of the week's proceedings. Then the meetings were so well attended throughout (excepting for a brief space on Thursday morning) that it may be said, without fear of contradiction, that in this respect they have never been excelled. The technical matter brought under the consideration of the members, too, was all very good, and much of it distinctly fresh, though in part suffering from inconclusiveness. Nevertheless, we firmly believe that the meeting inaugurates a new order of things in regard to the character of the papers offered for discussion. The association of the Institution with the Leeds University is unquestionably going to influence for good, and with broadening degree as time goes on. If this prediction be true, then it must be, speaking generally, that the tone of the technical contributions at the meetings will be raised, though in saying this we are not unmindful of, nor are we depreciating, the practical and valuable character of the papers that have gone before. There was a great amount of interest taken in the two papers emanating from work that has been conducted (in conjunction with, or through the instrumentality of, the Institution) at the Leeds University, and over which work Professors Smithells and Bone have been exercising a supervisory and directive interest that cannot be too highly appraised. The records of the work at Leeds should henceforth serve to supplement the technical programme at the annual meetings; and there can be no doubt that they will have a stimulating influence, from year to year, on individual research. There will thus be both a sensible and insensible elevating influence. One small point while on this subject. It was apparent in the discussion on the Gas Heating Research Committee's report that some of the members have not had the advantage that many younger members have had, through the present-day existence of technical schools and colleges, of receiving a training in physics; and perhaps it would not be a bad thing if the Committee, in their next report, would briefly define the differences between radiation, convection, and conduction. That they are not commonly understood is clear.

Still on the question of the papers, a number of manufacturers of gas stoves and burners were present at the meeting for the purpose of assisting with their views on the two papers bearing upon the articles they produce. Admittedly, time pressed; and all who desired to speak could not do so. We hope that these gentlemen, on the particular subjects which interest them practically, will continue to be invited by the Council to the meetings. But it is a pity, when they are so invited, and come to the meetings prepared to speak, that opportunity is not found for them to do so. There was not one burner maker called upon to make any remarks in connection with the paper on gas illuminating efficiencies; and only two gas-stove manufacturers on the gas-heating research report. Still, there is no doubt that the papers in which the representatives of practical work in the production of goods were concerned, supplied to them interest, matter for thought, and probably the germs of suggestion; so that the time spent in attending the meetings, it is to be hoped, is not regarded by them as having been fruitlessly expended. If any still desire to state their views on the papers in which they are concerned, our columns are at their service. One point is clear—that, with the increased application of scientific standards to efficiency, manufacturers will have to base their claims on, and prove their claims by, those higher standards. That is the trend of things; and it will be well to recognize it early.

It was with supreme gratification that the members heard the announcement at the meeting that the Livesey Memorial Fund now exceeds the minimum sum the promoters set out to accumulate. But the fund is not yet closed; and, after this meeting of the Institution, there may be others who will be desirous of contributing to it. This is an appropriate opportunity for saying that, upon the Advisory Committee that will soon be formed in conjunction with the endowment of the chair of Gas Engineering and Fuel at the Leeds University, there should be not only representatives of the gas profession drawn from the Institution, but the manufacturing section of the industry should be also represented by a nominee or nominees of the Council of the Society of British Gas Industries.

There have been many important happenings during the past Institution year. From among them projects the much-deplored loss of one who did much beneficent work for the industry. In reviewing the proceedings of this annual meeting, it seems more certain than ever that the good he did for the industry will be continued, through his loss, in other directions. No better form of memorial could any man desire; and it is as he whose memory is being perpetuated would have it be. The life in technical work as reflected by the proceedings last week augurs well for the future; and it is with much satisfaction that all associated with the industry may look ahead.

Presidential Address—Preparing for Future Residuals Competition.

A BROAD and philosophic reasoning lay at the base of the address delivered by the President at the opening sitting. It is a commonplace, and a somewhat conventional compliment, to say that *ex cathedrâ* utterances furnish food for reflection; but the phrase applied to the address by Mr. Glover carries with it a full meaning. The keynote was "looking "forward." The problems of the gas industry, both of internal and external origin, are in the present too great to permit of much time being spent in looking backward by those with the responsibilities of the industry upon their shoulders. But looking forward, the signs of the times, and the reading of what they forebode, are the only helps that lie at hand in shaping our visions as to what futurity has in store, to meet which preparation has to be made. It is necessary in these days, when humanity, in individual and corporate state, is striving to get the better the one of the other in the issues of life's struggle, to be, as far as it is humanly possible so to be, in advance of the times. That is where the President would have the workers and work of the gas industry be. Take his address as a whole, he opens up to us the conceptions of a thinking mind as to the increasing variety of the sources of competition. He brings before us visions as to the future; but they are visions of the intellect, and not of the volatile imagination. We have to prepare for the future, viewing our work in its entirety, from production to the ultimate destination of the produce. From the big reserve of scientific truth, there has to be evolved fresh laws which have to be orderly arranged and applied, from the beginning to the indefinable end of the profitable use of the products of the industry. In this work, the gas industry has recently called in the aid of a special department of the University of Leeds; and, in doing this, it is at the same time commemorating the labours of one of the most sentient workers the industry has ever produced—a worker who was not content only to look to the needs of the passing day, but was ever taking thought for the morrow when he should be gathered among those upon whose active work the final seal had been set. If more of the gas administrators of to-day had been possessed of the same perceptive power, the Livesey Memorial Fund would not have required six months to have brought it to the sum required for the endowment of the chair of Gas Engineering and Fuel. Those who have not subscribed to the fund will

be glad enough to, and will take care that they do, participate in the enjoyment of the fruits whatever they may be of this closer union of the gas industry with special scientific activity. What the outcome of the union will be, time alone can show. The President cannot predict; he can only surmise. In his view, the greatest value to be derived from the new University Department will probably be through an indirect influence upon the whole industry rather than by a direct and visible productivity. But we rather think the directive influence, which we would willingly place under the title of "visible productivity," will be of the greatest value to the future of the industry. No one who listened to the President's address, no one who has read it in our columns of last week, can help concluding that the conjunction is a good one, and a necessary one, and that it is being brought about none too soon.

It is in the commercial competition of the times that the President principally perceives the causes and the need for the reshaping of our ways in the gas industry. It is the natural order in the existence of things, that there should be increasing competition. Every development in any direction exposes the pre-existing to some fresh attack; and the measure of the success of the pre-existing energizes in corresponding degree the competition. The President did not take as his point of observation the narrow one of electricity being the only competitor. He went farther afield. And there is the warning underlying his words to take "Time by the forelock," and to get as far in advance as possible of the minatory rivals, and not wait to take action until they begin to strip more freely from the commercial position and opportunities now enjoyed by the industry. It is a question of preservation, and in good time; and it would be little short of suicidal to refuse to augur from the omens, and to act upon what is seen. Year by year, from coal carbonization in coke-ovens a greater amount of the very secondary products the gas industry yields, and from which a considerable proportion of revenue is derived, is being thrown upon the market, and brought into direct competition with the produce of the gas industry. The figures the President submits are significant. No less than 18 million tons of coal are carbonized annually in coke-ovens; but at present only 3½ millions are treated in recovery processes. The makers of coke for metallurgical purposes are not going to continue the wasteful system of non-recovery; and step by step more of the remaining 14½ million tons will be contributing to the products for sale. It is difficult, the President reflectively observes, to imagine this being done without disastrous effect on the markets for bye-products. Let us suppose the whole 18 million tons of coal carbonized in coke-ovens are eventually subjected to recovery processes, the tonnage of raw material so used would be 3 millions in excess of the amount of coal now carbonized in gas-works. The increased production of sulphate of ammonia and tar has not yet had any appreciable influence in depreciating prices; but all increased production makes greater the difficulty of appreciating prices. Already the coke from coke-ovens is competing with gas-works coke in industrial districts, and in others where a harder coke is required for furnace purposes. Even the fruit growers of Norfolk, who take a large proportion of the Norwich Gas-Works coke, are finding out that, by building somewhat larger furnaces, and using a keener draught, they can employ to greater advantage a harder coke than is obtained from ordinary gas-works practice. Again, in the coal and iron trade districts, the surplus gas from the coke-ovens is being employed for the generation of electricity. These things, we say, are significant. They need not create any alarm; but they must not be ignored. The gas industry is now in a strong and flourishing position; but big figures extracted from annual returns must not prevent us taking thought of the morrow.

It is this swelling competition for which we have to provide. Whatever is done will not prevent competition; but the industry can do its best to mould its practices and ways to the most effective form, in each locality, for resisting the competition by producing what is locally required in the way of gaseous and solid fuel, both for industrial and domestic purposes, at a price that will put at a disadvantage those in competition whose geographical situation is already against them. The paramount lesson that we extract from the President's address is that in the future, in our carbonizing systems, there must be no slavish acceptance of a, so to speak, uniformity of practice. The carbonizing plant of the future in a gas-works will have to be varied to meet he local conditions; the ambition of gas manufacturers in the future must be to become the providers of all local requirements for gaseous and solid fuel for industrial and domestic uses. The solid hard fuel that is needed by industry is not the type of solid fuel demanded for domestic purposes. To meet the two independent requirements as to quality, the carbonizing plant must be varied; and the major part of the plant that will be of greatest value in an industrial area may not be the best suited for the needs of a purely residential district. To provide the harder coke for the Norfolk fruit growers, and to resist extraneous coke competition in this direction, is the primary reason for the experiment with the three-feet deep chambers at the President's works, and the success of which in meeting a local requirement would alone, without other considerations, justify their extension. Their working will discourage others from sending hard coke into the district in competition, and from building plant to meet the requirement. Competition cannot be killed outright. But it can be checked; and it is the means to be adopted for this purpose to which the President devoted much attention.

The discussion of the revival of work in the carbonization field on lines that are running farther and farther from the long ruling practices, occupied a considerable place in the address. The study of the phenomena of carbonization and of the governing laws has long had possession of the President. In this connection, he made his first public utterances on the latest of his work with three-feet deep horizontal carbonizing chambers. From them he gets 12,000 cubic feet of gas per ton of coal, using South Yorkshire washed pea nuts; and he meets the local requirement (as already mentioned) for a harder coke than that produced in his ordinary horizontal retorts. From the experience with the chambers, sufficient has been learned to encourage the belief that there is nothing to fear in adopting larger ones where the size of the units, corresponding with the capacity of the works, is not unwieldy for meeting the varying demands for gas. The open mind is visible here; and, in fact, in treating of carbonization, there was almost throughout a non-committal attitude on the part of the President. In one place, however, there was one ray of light as to a preference in vertical working for the continuous system. "High ideals "are usually difficult of attainment. But evidence is not "wanting to show that substantial progress has been made; "and the pioneers who are now successfully emerging from "their difficult tasks are deserving of our sincere appreciation "and congratulations. Provided there are no unforeseen "collateral disadvantages to outweigh the many obvious "advantages attached to the continuous system, the out-"come promises to be not unworthy of the best traditions "of British conception and initiative." But a deserved and generous recognition was made of the work of German colleagues both in intermittent vertical retort and chamber carbonization, in the latter of which (the President thinks) there is a possible means whereby gas-works in industrial areas may meet the competition of coke-ovens in the supply of a hard solid fuel. And in the production of the solid fuel for household use, the President suggests that the claims of the Coalite system should not be rejected without consideration. In such ways, the broad views of the President were spread before his hearers. To meet all requirements, we have to go from the single practice in carbonization to double and perhaps triple practices. Will it pay? The systems that will ultimately survive will be those that will give "greatest value in products of the quality to suit local "conditions, accompanied by the least total expenditure of "fuel for heating, labour for operating, and capital expen-"diture." The final test commonly applied to processes is that of pounds, shillings, and pence. But it must not be overlooked that, important as economy is, the degree of success in repulsing competition and in retaining trade is subject to the character of the produce being meet to local requirement.

On leaving the subject of the exercise of foresight in preparing to encounter the enlarged competition already well upon the horizon, the President carried the members on to several other topics. The changed circumstances in connection with gas supply were of other subject-matter—including, even in a city like Norwich, the large proportion of gas now used for day consumption. Statistics prove an approximate average of 50 per cent. consumption before the hours of lighting set in; and when it is considered that the consumption as fuel for domestic and industrial purposes has not ended then, and that so large a proportion of the gas is now consumed in bunsen burners for incandescent lighting,

the argument for the total supersession of the illuminating power standard by a calorific power one gains strength. The necessity for extended propaganda work in connection with residuals was emphasized; and especially was support asked for the propaganda work abroad of the Sulphate of Ammonia Committee. The intelligence was conveyed that the Committee are now joining a combination of producers abroad for this purpose; and it is believed that, in this direction, there are offered openings for preventing prices falling to a low level. But in all the operations of the gas industry, the loyalty and interest of all ranks of workers are required. In securing that loyalty and interest, no man did more than Sir George Livesey. The address fitly opened with an appreciation of a noble life spent and ended. The loss was industrially the greatest and the most saddening event of the Institution year. He gave us much technically and administratively; he showed the way to humanize and intellectualize the workers. Has it occurred to all the administrators of the gas industry how, in the detail of the gas business, the responsibilities of the workers have been increased by the growth of the business and its changed character? The intelligent interest and co-operation of these workers are now more than ever necessary. How best are they to be gained? The answer is found in Co-partnership. The future of the industry depends upon the wise appreciation of the position in the present. Contentment with the present and apathy as to the future must not be allowed to cloud reason and judgment.

Gas Heating Research.

THE Committee appointed by the Institution of Gas Engineers, in conjunction with the University of Leeds, to make researches on gas heating, presented a report at the meeting which constitutes a record of much valuable preliminary work, and of the results of a set of completed investigations on a typical form of open gas-fire. The original work was started by Dr. Drugman in November, 1907, and continued after his resignation, in October, 1908, by Mr. E. W. Smith, M.Sc., who has made the set of investigations referred to.

The work done by these gentlemen, under the supervision of the Committee, has afforded results of sufficient importance and value to warrant a continuation and extension of the research. The ground has now been cleared by many months of preliminary work, and by the experience gained in the course of the investigation now reported; and subsequent researches should be conducted with far greater ease, certainty, and rapidity. It is eminently desirable that research on similar lines should be pursued with a view to determining the relative radiating efficiency of the different types of gas-fires, and of the effects of these fires on the air of rooms which they may be employed to heat. Having regard to the widely differing conditions in which gas-fires are installed, it is very difficult, if not impossible, to assess precisely the relative merits of two different types of fire without the use of what we may term a standard room for the comparative trials. The first work of the Gas Heating Research Committee was to establish such a room in a building adjacent to the Fuel Department of the University of Leeds. The room in question was built of double wooden walls, which were made as nearly as possible air-tight, so that the whole of the ventilation could be absolutely controlled by the observer. Similarly, the walls were designed to prevent exchange of heat between the experimental room and the outer room in which it was erected. The room was therefore in no sense comparable with an ordinary living room; and on this ground care must be taken that improper inferences are not drawn from the results, which obviously are not forthwith applicable to any ordinary conditions. The standard room merely affords a means to the observer of ascertaining approximately absolute values for the heating effects of the stoves examined; and, having regard to its circumscribed area—it is a 9 feet cube—it may be questioned whether, even in this respect, cumulative effects were not realized which would have been absent had a room of larger cubical contents been available.

For instance, the air of the room in some of the tests attained a temperature of over 85° Fahr., and results obtained from a gas-fire burning in an atmosphere of this temperature cannot be translated into corresponding figures for more ordinary temperatures. Obviously, the percentage humidity of the atmosphere of a room is largely affected by the temperature at which the room is maintained; and it would be entirely misleading to conclude that the air of a living room with the same type of stove would have even approximately the same degree of humidity as the air of the standard room which had been maintained for many hours at a temperature of over 85° Fahr., the drying effect of which on the walls and contents would clearly be quite abnormal. *Apropos* of humidity, it seems that the determinations in the experimental room were made by means of the ordinary wet and dry bulb hygrometer. If this is so, the humidity values must on this account also be considered unreliable. It is not long since the National Physical Laboratory had to report that a long series of investigations on the relative values of different standards of light under varying atmospheric conditions had been vitiated through the observations of humidity in the photometer-room having been made by the ordinary wet and dry bulb hygrometer, which, it has been well known for many years past, is unreliable in so far as indoor observations are concerned. ["JOURNAL," Sept. 15 last, p. 713.] It is a little surprising that the representatives of the University of Leeds on the Committee did not see that reliable means of estimating the humidity of the room were used. As it stands, we fear that no significance can be attached to the humidity determinations and the inferences which have been drawn in the report therefrom.

The rate of air change in the room was rightly estimated from determinations of the amounts of the carbon dioxide present in the outer air and in the flue gases, and the amount produced by the complete combustion of unit volume of the gas consumed; the rate of consumption also, of course, being known. The analytical methods employed are not stated in sufficient detail to enable an opinion to be formed as to their being appropriate and accurate enough for the purpose. The vague statement made in the report as to the mode of carrying out gravimetric determinations of carbon dioxide as a check on the volumetric method used is certainly unconvincing. Protest must be made against the pedantic fashion of stating the rate of consumption of gas and the calorific value of the gas in terms of unit volumes measured at 0° C., 760 mm., and dry. The ordinary English standard conditions of 30 inches, 60° Fahr., and saturated, should certainly have been followed for expressing the rate of consumption of the gas-fire used, and the calorific value of the gas. The two columns in Table I. of the Appendix to Mr. Smith's report, in which the rate of consumption and the calorific value are stated, as they stand, need translating into ordinary English terms before they will convey their real meaning to English gas men. It is also absurd in this country to state the temperature of a room in degrees on the Centigrade instead of the Fahrenheit scale. In these and some similar points, the members of the Institution on the Research Committee should see that academical modes are not allowed to detract from the general utility and value of the report. Consistency even is not displayed in this matter in the present report, for the weight of water vapour in the air is stated in grains, and not in terms of the metric system of weights. If the Committee realized that the metric weights in this case would not be readily followed by readers of their report, they should also have seen the futility of using other units based on the metric system, such as millimetres and calories.

The most valuable part of the report is clearly that which deals with the method of estimating the proportion of the total heat of the gas consumed which is radiated into the room, and the results of the estimations thus made. The figures obtained show that upwards of 35 per cent. of the total heat of the gas is radiated into the room. The mean figure is about 32 per cent.; and it is worth noting that the experiments lead to the conclusion that this figure is unaffected by the amount of air passing through the room. About 30 per cent. of the heat of the gas, however, was found in the experimental conditions to pass into the flue. Notwithstanding that these conditions were not altogether normal, it may be accepted that this figure represents approximately the proportion of heat ordinarily expended, when a room is heated by a gas-fire, in maintaining the draught of the flue, in order to secure the proper removal of the products of combustion and adequate ventilation of the room. It may, perhaps, be doubted whether, from the hygienic standpoint, this apparently large proportion of the total heat of the gas consumed is to any considerable extent wasted. Its curtailment, which is not in fact a difficult matter, would doubtless result in complaints of stuffiness by those accustomed to the free ventilating action of the

open-grate coal fire. There is a curious suggestion made by Mr. Smith—namely, that the pre-heating of the gas consumed in a gas-fire should be attempted as an alternative to the pre-heating of the air supply, which is more or less completely carried out in certain types of gas-fires. Having regard to the small volume of gas compared with that of the air required for its combustion, it does not seem probable that Mr. Smith's suggestion would lead to economy worth serious consideration.

It is to be hoped that the experiments will be continued under the guidance of the Committee, and comparisons made between various types of gas-fires, and, in particular, different kinds of radiating materials. For instance, comparative figures as to the radiating efficiency of the iron frets, which the late Mr. Thomas Fletcher found to be 50 per cent. superior in this respect to the ball "fuel" of his day, would be most valuable. There are many other types of "fuel," which it is unnecessary to particularize here, which should be tried in comparison with the typical "fuel" used in the gas-fire on which the present trials have been made. Also the Siemens type of reflecting stove which is so popular on the Continent should be included in the comparative tests. We opine that it would not show to advantage; and authoritative figures on this head would be most valuable in furthering the adoption of gas-fires of the English type and of English make in Continental countries. The Committee, however, should consider the advisability of altering their experimental room so that only a normal living-room temperature is reached, and also of securing determinations of humidity which shall be of greater value. They might with advantage secure the addition to their number of a chemist or physicist having a special knowledge of this class of research work. But already valuable work has been done by Mr. Smith under the guidance of the Committee; and it is only—we hope the Committee will accept the assurance—with a view to securing an enhancement of the value of their future work that the suggestions and criticisms here made are offered.

Carbonization and Conveying.

The mass of material referring to retort-house operations presented at the meeting, and the interest taken in it all by a big auditory, indicated how completely the subject has a hold of gas engineers and managers dealing with all grades in magnitude of operation—from the large works down to the small. We speak of carbonization being now in the transition stage. It is a long bridge over which crossing is being made; and matters are still in such an unsettled and inconclusive condition that it is difficult—nay, impossible—for many men to determine which of the new methods of working will eventually prove the superior. We have still to wait for installations of certain of the systems giving, on an ordinary working scale, a sufficient and reliable account of themselves. Even then, unless the conditions of working as between system and system are comparable, and the results are set forth in uniform manner, decision must still be difficult. What is wanted to clear the air are testings of some long duration on similar coals in the various types of setting. Results are presented from Durham, Yorkshire, and Derbyshire coals, Lancashire slacks, and unnamed British coals, used in different systems of working; but while the coals show, as a rule, improved results in vertical retorts over those usually obtained with horizontal retorts, it is impossible to place the figures side by side, and draw conclusions from them on which absolute dependence can be placed. Until we pass from this condition of chaos to a state in which workings are co-ordinated, so supplying the wherewithal for comparison, the means will not be available for adequately judging whether one system has an ultimate superiority over another, or whether the systems have equality, in working results, costs, and so forth, or whether one system has special applicability to one's local conditions.

However, the report presented to the Carbonizing Committee by Dr. Lessing, his paper on heavy charge chamber settings, and Mr. J. Ferguson Bell's communication on the results obtained by working large and long-hour charges in horizontal retorts, have set before us a great deal of interesting matter; but the utmost it has all done has been to show the extensive activity prevailing on the Continent and in this country in investigating new methods of carbonization. A careful examination of the material, however, does not disclose anything that can be said to add to the knowledge existing before the meeting, though we are grateful to Dr. Lessing and Mr. Bell for focussing, in an impartial way, within the limits of their opportunity, the work that is being done at this particular juncture. It is the view in Germany that the days of horizontal and inclined retorts are numbered, and that vertical retorts and large carbonizing chambers will be the things of the future. It must be admitted, too, that it is a recognition of a superior advantage in the vertical retorts that, since their advent, or rather since the publication of the first results of their working, British gas engineers have had their eyes opened to the fact that they can immediately improve both gas and coke production by the use of heavier charges in their horizontal retorts; and Mr. Bell's paper is illustrative of the point. In fact, to such an extent has this been proved that British gas engineers will be in no particular hurry to pull out their horizontal and inclined retorts in order to adopt verticals or any other form of setting. There are, however, advantages collateral with gas production in certain of the new systems that will, we believe, lead to an extensive adoption for replacement and entirely new installation work.

As between vertical retort settings and large carbonizing chambers, the recommendations so far to hand for the latter are not such that any feelings of preference can yet be aroused in this country on their behalf; and their only chance here seems to be—confessedly looking to the future only from the standpoint of present knowledge—in districts where gas-works are, for self-protection, compelled to preserve their industrial coke market by producing a much harder fuel. Even then, to save the large degradation of the illuminating power of the gas shown by Dr. Lessing to be the result of spacious chamber work, there will be a strong inclination towards smaller bulk carbonization, such as is being pursued by the President at Norwich, or in one or other of the vertical retort systems. Gains and losses have in these days to be seriously and comprehensively considered. Dr. Lessing recognized this—in fact, he was perfectly impartial in his presentment of the position of large chamber settings in Germany and elsewhere; and from all the information at his command, he declined to go the length of committing himself to any advocacy in their favour. Illuminating power, heavy capital expenditure, the wear and tear on structures by dumping in such heavy charges and by the strains set up on the chamber walls through the cooling effects of such large bulks of materials, the largeness of the carbonizing units, and the immense difficulty in the event of machinery breakdown in dealing with such quantities of coal and coke, are all disadvantages of large bulk carbonization that will weigh heavily as against the advantage of labour in the minds of British gas engineers. There is sufficient here, apparently, to neutralize any gain in labour; and labour economy can be purchased too dearly. It must also be borne in mind that the farther one departs from a reasonable weight of charge, the more one loses that exact control of operations and conditions that is so very essential with gas as the primary product of the operations.

The paper by Mr. Robert Watson on the advantages and disadvantages of conveying plant was a studious effort that deserved much more consideration than it received through being linked-up with the carbonization papers. It includes a no small amount of original investigation work; and its purposes were to prove that conveyors are profitably applicable to works of smaller capacity than has hitherto been regarded as feasible, and that the conveyor *per se* has hitherto had allegations levelled against it that are not justified by experience. Mr. Watson takes us beyond bare monetary considerations as between conveying and barrowing, and brings out subsidiary advantages of conveying that, though their value cannot be financially assessed, are such that they contribute to the economies of working. Conveyors have been much maligned as excessive breeze makers. Mr. Körting proved in our columns some time since, from the working at Berlin, that these adjuncts of the retort-house have more charged against them in this respect than is their due. Mr. Watson's paper confirms this. The conveyor is not the sinner; but the methods of dealing with the coke subsequent to its removal from the retort-house are at fault where there is excessive breeze production. It is to those subsequent methods that the engineer must direct his attention; and then he will find that breeze production submits itself very largely to engineering control.

The Best Gas for Incandescent Lighting.

The paper presented by Mr. Arthur Forshaw, M.Sc., the Institution Research Fellow in the Department of Gas Engineering and Fuel of the University of Leeds, deals with a fundamental question in the supply of gas for lighting

purposes—viz., the nature of the gas affording the highest illuminating duty with the Welsbach mantle. His investigations so far have only touched the fringe of this tremendous problem; but already they are valuable in confirming the view held by most thoughtful gas experts that flame temperature is at least as important as calorific value in incandescent gas lighting. The supreme difficulty in determining the relative illuminating values of different gases with incandescent mantles lies in the circumstance that each gas requires for the development of its maximum illuminating duty a burner specially designed for it, and a mantle specially shaped to fit the flame given by the particular gas in that burner. It is just this difficulty which has caused prolonged series of researches such as those carried out by M. Sainte-Claire Deville of Paris, and by Messrs. White, Russell, and Traver in the United States, to lead to comparatively inconclusive or even contradictory results. The investigators just named also had only to consider the upturned type of incandescent burner; but it is obvious that in future more importance will attach to the illuminating efficiency of a gas consumed in an inverted burner. So far Mr. Forshaw appears, like previous investigators, to have studied only the relative efficiencies of two gases in the upturned incandescent burner; and it is practically certain the results obtained regarding the latter are not directly applicable to the inverted burner.

Having regard to the greater importance at the present day of the inverted system of incandescent lighting, we need not discuss at length Mr. Forshaw's efforts to obtain a standard burner of the upturned type with which to make comparisons of the relative illuminating efficiencies of carbon monoxide and hydrogen. He selected a burner which could be adapted for either the No. 0 or the No. 2 Welsbach mantle, and found, as was to be expected, that, when it was adapted to consume carbon monoxide to the best purpose, it was wholly unsuitable for the combustion of hydrogen. He desired to measure the internal air supply to the bunsen flame for each gas, and adopted for the purpose a meter, with governor, supplied with air through reducing-valves from storage cylinders, in which it was compressed at 200 atmospheres. The air supply was fed at a rate measured by the meter into the burner's mixing chamber, which was closed to the outer air. This arrangement must surely have required a great deal of care and watchfulness, to ensure the internal air supply of the burner being at even approximately atmospheric pressure; and we do not see that Mr. Forshaw mentions what gauge he used in order to ascertain that the air did flow into the mixing chamber under the prevailing atmospheric pressure. Any deviation from the atmospheric pressure for the internal air supply of incandescent burners causes so serious a departure from the normal conditions of the combustion of gas in such a burner, that erroneous deductions are very liable to be drawn from the results obtained. Once the pressure of the air supply of an incandescent burner is varied, however slightly, from the natural atmospheric pressure, the conditions of combustion and the liability of the flame to strike-back to the nipple are seriously affected. We cannot but think that Mr. Forshaw would have been well advised to have adopted Winkler's method of measuring the internal air supply to a gas-burner, with either a smoke or torsion-vane gauge, as described some time since in the "JOURNAL" [Sept. 20, 1904, p. 803, and Sept. 3, 1907, p. 625].

Assuming, however, that Mr. Forshaw was able, with his less satisfactory arrangement, to regulate the air supply to the standard experimental burners exactly to atmospheric pressure, the results he obtained are very interesting. For hydrogen, he found it necessary to design a form of burner which, as he points out, is very far removed from anything which is likely to be used in actual practice, as the burner-head was provided with a water circulation for cooling purposes. No doubt very many forms of burner were tried before this type was evolved and chosen as the most suitable; for it is stated that several months of experimental work were devoted to modifying the construction of the head of the burner, in order to secure good aëration of the hydrogen flame without its striking-back. An account of this experimental work might indirectly furnish some valuable hints to makers of incandescent burners. It has so often in the past been assumed that the bunsen burner could not be adapted for a particular purpose—such as for inverted lighting, and for the consumption of acetylene—and subsequent investigation has proved the assumption to be entirely groundless, that we are reluctant to believe that a practicable bunsen burner for the consumption of hydrogen for incandescent lighting is not feasible. We wonder whether Mr. Forshaw has followed the evolution of the modern incandescent acetylene burner. The significance of these remarks lies in the fact that comparative results of the illuminating efficiences of the two gases are of little value unless both gases have been consumed in the burner and with the mantle best qualified to afford the maximum illuminating duty from each. It is palpable that the same burner and mantle are not likely to be equally suitable for two gases of such widely different physical and chemical properties as carbon monoxide and hydrogen.

It is, however, permissible to take another view of the question, and to hold that mantles, and, in a smaller degree, burners, have now become standardized in respect of form and size, and that the comparative illuminating efficiencies of different gases must be judged solely by reference to their performances when consumed in the typical consumers' burner with a mantle of the most usual size and shape. If this view were adopted, it would probably be right to accept the Welsbach "C" burner and mantle for the comparative tests of different gases. Investigators seem hitherto to have started their tests with the intention of following this plan; but, as soon as they have departed from the use of gas approximately of the same character and quality as that supplied to towns at the present time, they have been impelled by the course of their investigations to diverge from it. Mr. Forshaw, almost from the outset of his work, gave up the consumers' burner; but he seems to have adhered throughout to mantles of stock size and form. It is hard to see why, once departure from the ordinary consumers' equipment is admitted, it should be confined to the burner and not be extended to the mantle also. The view that the comparisons should be made with a stock typical burner and mantle may, of course, be logically upheld; but little defence can surely be offered of the intermediate method followed by Mr. Forshaw of varying the burner but not the mantle. We think, however, that it would be a great mistake to assume that any burner or size or form of mantle may be regarded as a stereotyped pattern to which any illuminating gas which it may be desired to employ should adapt itself. The span of time required to effect a complete transformation of the burners used by a gas-consuming community is after all but short, as will be realized by a consideration of the decade which witnessed the displacement of the flat-flame by the upturned incandescent burner, and of the subsequent decade, in which we now are, which is witnessing the supersession of the upturned by the inverted burner. It would, therefore, seem certain that, if it were shown that the only obstacle in the way of the adoption of a new illuminating gas was that, for the development of its highest illuminating efficiency, a new burner or a new form of mantle was requisite, the obstacle would not avail to prevent its adoption. Consequently, in an investigation of the intrinsic illuminating duty of a gas with the Welsbach mantle, the greatest latitude should be admitted both in the type of burner and in the form and size of mantle, consistently with the idea that any such burner or mantle tried should be of such a nature that it could be produced if necessary on a manufacturing scale, and manipulated without difficulty by an unskilled consumer. Within the limits of variation of the burner accepted by Mr. Forshaw, he has shown that carbon monoxide is unquestionably a superior component of a gaseous mixture intended for use for illumination with upturned incandescent burners. We hope that he will shortly demonstrate whether the same conclusion holds good in regard to inverted burners.

The bearing of the experiments with the two gases, carbon monoxide and hydrogen, on ordinary gas supplies, has not, we think, been sufficiently indicated or emphasized in Mr. Forshaw's paper. It is not merely a question of whether one or other of these gases in the free or elemental state should preponderate in lighting gas. If it were not otherwise, apparently the aim of the gas-works' engineer, who primarily considered the requirements of the incandescent burners in his district of supply, would be to suppress as far as possible the amount of hydrogen in his gas, and to increase the amount of carbon monoxide. Disregarding for the nonce the objectionably toxic character of the latter gas as a component in large proportion of a popular gas supply, it would be no difficult matter to effect this variation up to a certain point by modification of gas-works' plant and processes. Actually, however, much more than this is involved in the question as to the relative illuminating efficiencies of the two gases. All the

combustible constituents of ordinary heating or lighting gas other than carbon monoxide and hydrogen may be regarded as sources of these two gases in the bunsen flame. Thus the hydrocarbons may be regarded as breaking up in the flame into a water gas consisting of hydrogen and carbon monoxide, the relative proportions of which in the water gas vary according to the ratio of carbon to hydrogen in the particular hydrocarbon.

Consequently, it would appear to be demonstrated that the hydrocarbon which would thus afford the greatest proportion of carbon monoxide to hydrogen would be the most suitable component of an illuminating gas. Having regard to the fact that the hydrocarbon in question must be gaseous at the prevailing temperature and in the degree of dilution in which it occurs in the lighting gas, it would seem established that acetylene or benzene would be far superior hydrocarbons to ethylene or ethane for incorporation in lighting gas. Hazarding a conjecture (which we hope Mr. Forshaw may eventually prove or disprove), it seems probable that an almost ideal gas for lighting with the Welsbach mantle, having regard solely to illuminating efficiency, would be a mixture of carbon monoxide and acetylene, or, in default of that, carbon monoxide and a small proportion of benzene. The real difficulty this problem presents to the gas maker is to find a more satisfactory diluent than the hydrogen that at present predominates in both coal gas and water gas. In coal gas the deleterious influence of the hydrogen is offset by the presence of a considerable amount of methane. In water gas, there is no such counteracting influence; but the carbon monoxide is in higher proportion.

Working Costs and Capital.

THERE were two papers read (they were the final ones) dealing with the finances of gas undertakings—the one, by Mr. Herbert Lees on a study of working costs; and the other, by Mr. Arthur Valon, in which he made a suggestion for the redemption of capital by gas companies, in order to reduce the capital account and charges per unit of output. Mr. Lees' paper traverses so much ground, and shows so much industry, that it is impossible to do more here than make a few cursory comments upon certain of its features. His study shows that there has been progress in working economy all round, but that the working economy has been largely nullified by increased expenses in other directions. Wages have gone up, distribution expenses have increased, rates and taxes have also advanced, and coal has risen in price, and is likely to maintain a higher normal level than hitherto. In company working, the best of administration and ingenuity could not have obviated any of these increased expenses. But in connection with municipal trading concerns, the considerable extent to which labour dominates the actions of the governing bodies, and the prodigal administration of many authorities, have had effect upon the expenditure of their own undertakings; and this, in turn, has borne heavily upon private enterprises, among them gas-works. But speaking of the expenditure of gas undertakings generally, it is obvious from the paper that, had it not been for improved working, and the adoption of mechanical means of operation, it would have been a bad thing for the gas consumer, therefore for the progress of the gas industry, and consequently for labour. The workers in the gas industry, it is clear, have nothing of which to complain; economy in the industry has been their defence, and has widened the field of employment.

Among the many points brought out by Mr. Lees is also this, that the make per ton of coal is an illusory basis on which to institute working comparisons, unless the character of the coal used is known. The ultimate surplus revenue per 1000 cubic feet of gas sold, having regard to the price charged for gas, is a safer one. It is in many cases an economical proceeding to buy cheap local coals of a low gas-yielding variety, rather than purchase from a distance a superior coal of a high gas-yielding quality; and in those cases, there are examples of concerns with low gas yields per ton exhibiting a better ultimate financial return than others with higher makes. The largest profitable gas yield from the coal that it is the most economical for him to purchase is, of course, the aim of every gas man; but the point as to the ultimate yield of a low gas-producing coke is one that is frequently overlooked in discussions where makes per ton are quoted. There is one thing before leaving Mr. Lees' paper to which we should like to call his attention; and it is that had he taken the London Companies' figures for 1908, instead of for 1907, the comparisons of the workings would, generally, have been more favourable to them.

Regarding Mr. Valon's proposition as to redemption of gas companies' capital, we are in full agreement with him that a low capital is conducive to a low price for gas; and that the lower the capital in future, the better will it be for the concerns. The question, however, is which is the preferable way, under the circumstances of the time, to reduce the capital expenditure—by a fixed setting aside to a redemption fund, or by charging as much as is legitimate and proper to revenue account for replacements, maintenance, and depreciation, and, whenever the occasion is favourable, reduce the price of gas, and so create new business. The addition of the obligation of a redemption fund to what companies, or wisely administered ones, are already doing, would operate to defer reductions of price; and this would make it all the more difficult to expand and consolidate business in competition with other illuminants. To both present and future consumers, and to both the present and future interests of the companies' undertakings, this would be prejudicial. Nor would it be fair to compel the shareholders to forego any portion of their present dividends. The yield on gas investments to-day is not more than the holders are entitled to; and, looking down our stock and share list, it strikes us that some of the holders would not think it at all amiss if their returns were a little higher. The reduction of capital in the way proposed by Mr. Valon would, we feel certain, be an advantage at present to competitors, and that would be a "sacrifice" we at all events are not prepared to advocate. Nor do we think many gas companies will be willing to endorse Mr. Valon's view.

There is another point. The difference existing between the capital of companies and local authorities per million cubic feet of gas sold is partly due to the big proportion of small companies compared with municipal undertakings; and these are just the companies whose capital requires reducing, but who would be injured most by Mr. Valon's method of effecting the reduction. He says that capital redemption for companies would be much the same thing as the sinking fund for municipalities. It would not now be for many companies. The geographical and the trading conditions of the majority of the municipal gas undertakings of the kingdom is altogether different from those of a very large number of the company undertakings. The operation of their sinking funds commenced many years ago before the undertakings had grown to their present dimensions, and before competition was so rife as it is to-day. Several of the undertakings more recently transferred are suffering greatly from the necessity of having to provide the money for sinking fund, which causes comparatively high prices for gas to obtain. The fact of the matter is that Mr. Valon's proposal has come—shall we say?—some thirty or forty years too late. What he desires must now be obtained by another method. Moreover, in view of the restrictions that Parliament has been putting during the last two sessions upon gas companies in the matters of appropriations from revenue and the amount carried forward, there would be, we fancy, some difficulty in persuading the authorities to allow the creation of the additional fund proposed. In the case of the Gaslight and Coke Company, there were special reasons for the wiping-out of part of their capital.

The Design of Atmospheric Burners.

In another column of to-day's issue of the "JOURNAL" will be found an exceedingly interesting communication from Mr. Alfred Mansfield, of Liverpool, on "The Design of Atmospheric Burners." The writer points out that one of the many problems arising in this connection is the relation of one orifice to another; and he says he does not know of any tables which give this information in a manner that will be serviceable to busy men. He has been obliged to work them out in his own laboratory, and he publishes them in the hope that they will be of service to others. He gives clear directions for the use of the tables. He claims for them that they facilitate the correct calculation of the relationship between the issuing orifices and the mixing-tube of a burner; and that when once a satisfactory burner has been designed, a smaller or a larger one can be produced which will give exactly the same efficiency. Another feature of the tables is that if the consumption of gas of a certain quality by one burner is found, the consumption for any other size can be calculated with exactitude for the same quality of gas.

The Gaslight and Coke Bill.

At length, the Gaslight and Coke Bill has been released from the obstruction of Mr. William Thorne; and it has now been read the third time and passed. Mr. Thorne did not give in. He carried his opposition to the utmost limits, and challenged a division, with the result that he got badly beaten in a comparatively thin House. This was on Thursday, and what then took place will be found fully reported in our "Parliamentary Intelligence." Mr. Thorne made many statements, several of which were sufficiently incorrect to have been misleading if submitted to an unintelligent audience. In effect, he asked the House for a verdict on an *ipse dixit* statement containing conclusions entirely opposed to the findings of Mr. Mooney's Committee after a thorough and impartial trial of the proposals of the measure in all their bearings, and after a thorough investigation on the part of, and settlements with, the City Corporation, the London County Council, and the East Ham and other Borough Councils, but not the West Ham Council, who stood alone discontented. Upon that Council is Mr. Thorne, and many others who think like him, and have only one object in view in their public and political life. Mr. Thorne suggested that the Bill had been "rushed;" he also used the word "artful," and suggested that nearly everybody had been "squared." The rushing process has been a wearisome business. To get the Bill forward to its present stage has been something like the "rush" experienced in punting against a swift stream. If Mr. Thorne had only thought a little more before he spoke, it might have occurred to him that the terms "rushing" and "squaring," as used by him, do not run together. "Squaring" councils is slow work; and such "squaring" as there had been amounted to satisfying local authorities by giving as much as could reasonably be conceded in the interests of ratepayers and consumers. The whole secret of Mr. Thorne's opposition on third reading (he did not oppose on second reading) was because the West Ham Corporation did not get all they irrationally wanted the Select Committee to give them. But they did get a considerable part of what they asked for through the consent of the Gaslight and Coke Company to substantially continue as before the Bill was introduced the works at West Ham for a further ten years. Sir Daniel F. Goddard (whose lifelong interests in the gas industry are well known), Mr. Mooney, and Mr. A. C. Morton all exposed to the House the hollowness of the case put before it by Mr. Thorne; and the House showed its sense of the position, and the value of the statements made by the mouthpiece of the opposition, by rejecting the amendment by 203 votes to 43. Parliament has before declined to reverse the decisions of Select Committees on the superficial declarations of individual members; and this is an added instance.

Co-Partners and the Budget.

The Chancellor of the Exchequer is going to have no mercy on those of the workmen shareholders in co-partnership concerns who have accumulated a little capital. Mr. Joynson Hicks, one day last week, put it to Mr. Lloyd George whether he did not think the dividends of such workers were purely earned money, and whether in that case he could not see his way to allow the dividends to be treated as earned income rather than as unearned income for purposes of differentiation in income-tax. The Chancellor of the Exchequer announced that he was unable to extend special treatment to these particular shareholders. So that a few of the more "bloated" capitalists among the co-partnership gas workers will have the privilege of paying a little into the National Exchequer at the 1s. 2d. rate in the pound.

A National Miners' Conference.

For the purpose of considering, among other matters, the position created by the coming into operation of the Mines Eight-Hours Act, and the attitude of the employers in regard thereto, a national conference was held in London last week of the Miners' Federation of Great Britain. The proceedings lasted two days; and though from the very commencement the men's leaders seem to have fully realized the seriousness of the position in which they now find themselves, one or two of them at the conclusion of the meeting expressed themselves as still hopeful of a peaceful solution—though there is still a firm determination not to give way on the sixty-hours' and double-shift questions. In the first place, the conference agreed that the President and Secretary of the Federation, together with a member of the Executive, be appointed to assist the miners' representatives of South Wales in their endeavour to arrive at an amicable settlement of their dispute. This does not amount to very much as a step in the direction of peace; but it is at any rate to be hoped that it will not still further complicate matters. There is, however, a chance that it may do so, in view of the contention of the employers that the circumstances of the South Wales coalfield differ so much from those in the North of England, that they cannot allow any interference from the outside. The conference also decided that an effort should be made to arrange a joint meeting of coal-owners of Great Britain and the Federation, to consider generally questions arising out of the new Act; but in view of the resolution of the South Wales owners just alluded to, it seems hardly likely any good can result from this proposal. Perhaps the most important conclusion come to was the confirmation of the following resolution passed some six weeks ago: "That this conference, after hearing the reports of the districts upon the question of the introduction of the Eight Hours Act, resolves that it be an instruction to each district affiliated to the Miners' Federation of Great Britain to decline to accept any reduction in wages demanded by the coalowners consequent on the coming into operation of the Act; and should any district be attacked upon the wage question, or upon the question of extending working hours from eight to nine under the sixty-hours clause, a national conference is to be convened to decide what defensive action is to be taken." The only inference to be fairly drawn from this is that the men are just as determined as ever to stand firm; while there is, on the other hand, no indication that the employers are intending to recede from the position which they have taken up—or which, as they urge, has been forced upon them by the Eight Hours Act. Meanwhile, the existing position of affairs is summed up in the report that "business is at a standstill; and further examples of how trade is being diverted to other markets by the prevailing uncertainty were afforded by the placing of an order last Friday with a German Kiel firm for the supply of 18,000 tons of Westphalian coal to German warships, and the placing of a French order for 50,000 tons also with the Germans."

Progress in Constructional Gas Engineering in Germany.

It may be remembered that early this year two articles under the above title appeared in the "JOURNAL," calling attention to a fine album which the Berlin-Anhaltische Maschinenbau Actien Gesellschaft had recently issued, containing more than 700 illustrations of plant and apparatus constructed by them within the past six years. The illustrations, with the brief explanations (in German) accompanying them, filled about 300 pages; and the album constituted, as claimed by the important firm issuing it, "a general review of modern gas-works machinery." We refer to the articles again to mention that an English edition of the album has now been issued, bound in a style similar to its predecessor; and we have no hesitation in qualifying it as one of the most handsome catalogues of gas-works plant that have ever come under notice.

English Capital Invested Abroad.

An interesting account of the large sums of money that have during recent years been invested abroad by British capitalists was given at the Royal Statistical Society last Tuesday by Mr. George Paish, Joint Editor of the "Statist." He said the Commissioners of Inland Revenue set forth in detail the amounts received from certain classes of investments, amounting in all to about £80,000,000—a sum which he considered to be under-estimated by about £3,000,000. They did not include, however, investments in public companies. In order to amplify the information published by the Commissioners, the author obtained the reports of as many miscellaneous companies who have raised capital publicly in this country as he could; and, after analyzing them, he concluded that British income from these sources amounted to nearly £58,000,000 a year, bringing up the total to £138,000,000. In this are included £1,200,000 for gas-works, and £400,000 for water-works. To obtain an income of about £140,000,000 per annum, Great Britain has invested something like £2,700,000,000, and is obtaining an all-round return of 5·2 per cent.

GAS STOCK AND SHARE MARKET.

(For Stock and Share List, see p. 914.)

A NARRATIVE of the course of events on the Stock Exchange during the past week might almost be confined—not unfittingly in Ascot week—to the more "sporting" markets, the American, South African, and Mining. Business in the others was at no time active or at all interesting. In the vivacious lines indicated there was no lack of excitement, especially as the tendency varied upwards or downwards. The opening day found the tone favourable in good investment stocks, and Consols had a slight advance, while Railways were firmer. But the Foreign Market was uneven, and South Africans weaker. Tuesday was another quiet day; and the tendency in many markets was irregular. Wednesday was dull; the predominant influence being the weakness of speculative lines recently rushed up, to account for which various causes were put forward. This weakness was again apparent on Thursday; but the gilt-edged class was stronger. Consols rose $\frac{1}{16}$. Uneasiness regarding coals was a lowering factor in Railways. Friday maintained the strength of Consols and their like; but it was a bad day for the speculative markets. On Saturday the positions were reversed; the losers and the gainers of the previous day entirely changing places. In the Money Market, conditions were easier owing to a reduced demand; and rates for short loans and discount closed lighter. Business in the Gas Market was on a considerably reduced scale, and not a single issue (with the possible exception of South Metropolitan) was up to its recent average of activity. But the tendency was very favourable, and a good many quotations were advanced. Gaslight and Coke ordinary was unchanged, though prices pointed rather downward, with transactions at from 103 to $103\frac{7}{8}$. In the secured issues, the maximum realized $88\frac{1}{4}$ and $88\frac{7}{8}$, the preference from $105\frac{1}{4}$ to 106, and the debenture from $84\frac{3}{4}$ to $85\frac{15}{16}$. In South Metropolitan, prices ranged from 122 to $123\frac{1}{4}$. The debenture made $85\frac{1}{4}$. In Commercials, the only bargain was in the 4 per cent. at $109\frac{3}{4}$. In the Suburban and Provincial group, Alliance and Dublin new changed hands at $12\frac{3}{4}$ and $12\frac{13}{16}$, Brentford new at 196 (a rise of 1), British at $42\frac{7}{8}$ and $43\frac{1}{4}$, and West Ham at 121 and $121\frac{1}{4}$. Quotations rose in Brentford old and debenture, in both Ilfords, in Liverpool A, in Newcastle debenture, in Tynemouth, and in West Ham preference. In the Continental companies, Imperial was quiet, at from 179 to 180, ditto debenture made 97, Malta $4\frac{3}{4}$, and Union from $96\frac{1}{2}$ to $97\frac{1}{4}$. Both European issues advanced without business being done. Among the undertakings of the remoter world, Buenos Ayres realized $13\frac{7}{8}$ to $14\frac{1}{8}$, Melbourne $4\frac{1}{2}$ per cent. $101\frac{3}{4}$, Monte Video $12\frac{1}{8}$ and $12\frac{7}{8}$, Primitiva $6\frac{3}{4}$ to $6\frac{31}{32}$, ditto preference $5\frac{3}{8}$ and $5\frac{5}{8}$, River Plate $14\frac{7}{8}$ and 15, San Paulo $14\frac{1}{8}$, ditto preference $12\frac{1}{8}$.

IMPORTANT RETURN ON MUNICIPAL TRADING.

THERE were issued last week, in compliance with an order of the House of Commons, two instalments of a return in relation to municipal trading in the United Kingdom which was moved for as long ago as Dec. 20, 1906, by Mr. Chiozza Money, the Member for North Paddington. The return was to show for the London County Council, the Corporation of London, the Council of each of the Metropolitan Boroughs, and the Corporations of a number of Provincial towns, including those of Edinburgh, Glasgow, Dundee, and Aberdeen, the nature and extent, and, for each of the last four years for which figures were available, the financial results of reproductive municipal undertakings, including for each separately "a short description, the date and terms of its original acquisition or establishment or its subsequent extension, how managed, capital employed and how obtained, value of the undertaking, capital paid off and outstanding, loan charges, provision for depreciation, gross income and expenditure, net profit or loss, how profit is allocated or loss met, amount of relief or burden to rates, number and salaries of the chief paid officials, number of workpeople, rate of wages paid in the chief classes of labour, and prices charged for products or services supplied or rendered." It will be acknowledged that this was a "very large order;" and probably no surprise will be expressed at the length of time which has elapsed between the giving of, and the compliance with it, when it is stated that the present issues, which are only the first and sixth instalments of the complete return, extend to 110 and 83 foolscap pages respectively, and yet the particulars presented relate only to the Corporations of Bradford, Halifax, Huddersfield, Leeds, and Sheffield—all situated in the West Riding of York, and the Corporations of Edinburgh (including the Edinburgh and District Water Trustees and the Edinburgh and Leith Gas Commissioners), Glasgow, Dundee, and Aberdeen.

A Memorandum which precedes the statistics for the English towns gives a good idea of their scope. The municipal boroughs in England and Wales mentioned in the order are all those which at the date of the Census of 1901 had populations of upwards of 90,000, with the addition of the municipal boroughs of Stockton-on-Tees and Blackpool, the populations of which were 51,478 and 47,348 respectively. The aggregate population of these boroughs and of the Metropolitan areas mentioned was 12,183,163 in 1901, and their aggregate area was 400,694 acres (land and inland water only), allowing for alterations of area that have taken place since that date. The total population of England and Wales was then 32,527,843, and the area 37,327,479 acres. The average population per acre in the places in England and Wales to which the return relates was therefore 30·4, compared with 0·6, the average for the rest of England and Wales.

With a view to securing uniformity in the classification of the numerous details required, the local authorities were invited to group together the particulars in respect of each undertaking under its head, and to subdivide them as follows: (1) Capital, (2) income and expenditure, (3) scales of prices charged, (4) number and remuneration of officials and workpeople employed, (5) nature and extent of the undertaking, (6) system of management, (7) observations as to entries contained in any of these divisions. The plan thus outlined has been followed in compiling the return, with the exception that, in cases where the local authority carried on more than one undertaking, the particulars relating to the capital of the several undertakings have been printed in one table for each area. Those furnished by each local authority are brought together and are prefixed by a table (prepared by them) showing the acreage of the area on March 31, 1906; the rateable value of the area at the same date; the estimated population in June, 1905; and the total number of members of the town or other council in the year 1905-6.

It was not practicable to secure that all the entries relating to the capital, income, and expenditure of the several undertakings should be made on a uniform basis in the return. It was therefore left to the officers of the local authorities concerned to place their own interpretation, for the most part, on the terms of the resolution of the House. With a view to avoiding undue divergencies of method, however, detailed forms were issued by the Local Government Board on which the entries referred to could be made. Further, explanatory instructions as to filling up the forms were afforded from time to time, as was found necessary. In order to give effect to the general intention of the resolution, particulars not specifically required are included in the return.

The Memorandum under notice is signed by Sir S. B. Provis, K.C.B., Permanent Secretary to the Local Government Board; the statistics relating to the places beyond the Tweed being preceded by one signed by Mr. James M. Dodds, C.B., Under-Secretary for Scotland. The former remarks (though this is scarcely necessary when one merely glances at the mass of tabulated statistics) that the preparation and verification of the statements contained in the return imposed considerable labour and trouble upon the officers of the local authorities concerned; and the Board express their appreciation of the services rendered in this matter by those officers. Whether all this labour and expense will be of permanent value to those who have to pay for it, we need not stop to consider, seeing that, by sanctioning the return, the Legislature evidently thought it would.

Carbonization in Bulk.

As bearing upon the subject of carbonization in bulk and the production of residuals, which was dealt with by Mr. Thomas Glover in his Inaugural Address at the meeting of the Institution of Gas Engineers last week, Mr. Charles Hunt has sent us the following extract from the paper, entitled "Notes on Residuals," which he read before the former Institution in 1896: "Although carbonizing in bulk may at first sight appear to be but remotely connected with the subject of residuals, it will, upon consideration, prove to be intimately associated with it. When the Simon-Carvès system of coking was introduced into England some years ago, the author was led to hope that in some such plan might be found a solution of the labour question as affecting gas manufacture; and he so expressed himself in his presidential address to the Gas Institute in 1881. The idea, however, seemed at that time to be almost too venturesome to follow up. But without being at any time actually abandoned, it has been revived by the rapid and practical advances in the same direction which have been made on the Continent during recent years, and which are, in a great measure, the cause of the fall in value of tar products and ammonia. When on a visit to Belgium, with the Iron and Steel Institute during the autumn of 1894, the author was enabled to realize, by actual observation, the large scale on which the recovery of residuals is being pursued there in connection with the manufacture of coke for metallurgical purposes; and it was but natural to contemplate what might be the effect upon the values of gas residuals of an extension of the system here, where many million tons of coal are annually used in this industry. In what light, then, ought the system to be regarded? Ought it to be approached as a possible ally, keeping in view its advantages in the saving of labour, or must its advances be watched at a distance, as those of, to all outward appearance, an intractable competitor?"

The Munich Chamber System.—We are informed that the Coke Ovens and By-Products Company, Limited, of Nos. 141, 142, and 143, Palace Chambers, Westminster, S.W., have entered into a contract with the Ofenbau Gesellschaft M.B.H. of Munich as sole licensees to construct the Munich chamber-furnaces in Great Britain and the Colonies. There are built, and under construction, chambers of a capacity equal to 2000 tons in 24 hours. At present, all these are on the Continent, and include Munich, Hamburg, Leipzig, Paris, Rome, Berlin, Hanau, and Regensburg (two installations). The new chambers at Munich and Rome have each a capacity of $6\frac{1}{2}$ tons, or $19\frac{1}{2}$ tons per setting of three chambers.

THE INSTITUTION OF GAS ENGINEERS.

PROCEEDINGS AT THE SEVENTH ANNUAL GENERAL MEETING,

HELD AT THE

INSTITUTION OF MECHANICAL ENGINEERS, STOREY'S GATE, LONDON,

JUNE 15, 16, and 17, 1909.

MR. THOMAS GLOVER, OF NORWICH, IN THE CHAIR.

REVIEW OF PROCEEDINGS.

(For full Report see page 817.)

GLOOMY meteorologically though the morning of the opening sitting of the members of the Institution was—though to be accurate be it said there was a fitful breaking through of the sun's rays—there was no gloom in the animated throng that one met outside and in the vestibule of the Institution of Mechanical Engineers. In a body of professional men of the same calling, and situated as are the officials of the gas industry—all possessing common aims and ambitions—there are no piquant animosities, no dividing rivalries or partizan adherencies; and nothing but goodwill need prevail. The heartiness of the abounding greetings was the manifestation of the general goodwill and of the recognized community of interest that unite one and all in the bonds of friendship. Not only was the home profession well represented, but there were among the visitors friends in the calling from across the sea. The genial face of Dr. A. H. Elliott, the Engineer-Chemist of the Consolidated Gas Company of New York, was noticed; and the members felt more than honoured that Mr. A. F. P. Hayman, of Berlin, had come so far to receive the medal awarded him for his paper last year. And from Copenhagen on this occasion came Mr. Wissing, the Manager of the Valby Works, a description of which Mr. Irminger, the Chief Engineer of the Copenhagen municipal gas-works, gave to the members last year. Mr. Leonard G. Barber, Assistant to Mr. James C. Watson, the Engineer and Manager of the Oriental Gas Company, Calcutta, was also present. But apart from the personal interest attached to this first stage in the reunion, there were on view certain interesting models in the vestibule, together with a copy of the bust of Sir George Livesey from the deft hands of Mr. Sydney March; and this attracted a considerable amount of attention. Just inside the lecture hall was the oil-painting of Sir George, by Mr. Edward March, which has been purchased by the Directors of the South Suburban Gas Company for their Board-room. On all hands, it was agreed that in features, expression, and attitude, the artist had caught with wonderful truth the characteristics in these respects of the late leader of the industry.

Punctuality is the soul of business; and the President—Mr. Thomas Glover—numbers this principle among his virtues. The hands of the clock had only just passed the stroke of 10.30 when he entered, accompanied by a long line of the Council; and the members gave them a vocal greeting, both general and cordial. Immediately to the right and left of the President were those upon whom the honours and responsibilities of the chief office will in due season fall—the Vice-Presidents, Messrs. James W. Helps and Alex. Wilson—and with them were the Honorary Secretary (Mr. S. Y. Shoubridge), and the unremittingly energetic Secretary, Mr. Walter T. Dunn. The introductory business formalities were negotiated almost before some of the members were fully aware that the proceedings that marked another stage in the Institution history had commenced. Then the Council's report was presented; and it was imagined from the pause that followed the inquiry from the President as to whether any member wished to remark upon it, that the report would pass without comment. Not so. Mr. Carr was on his feet, desiring to ask a question as to a paragraph. The President suggested that Mr. Carr should read it. Mr. Carr replied that there was no occasion to do so, whereupon there was a ripple of laughter all through the hall. Everyone present knew that there was only one subject to which Mr. Carr was likely to refer, and that was the one as to the deputation to the Board of Trade on the question of unifying the standard burner for gas testing throughout the British Isles, and the suggested promotion of a Bill for the purpose. The members are beginning to look upon this as a sort of foible of Mr. Carr. But be it said he spoke, on this occasion, in perfectly friendly tone. The promotion of such a Bill he believed would be strenuously opposed by local authorities, and would involve the Institution in very heavy expense. In his opinion, if the Council had followed a course of non-intervention in this matter, it would have been distinctly better. But then Mr. Carr went further, declaring that, while he had no objection to the "Metropolitan" No. 2 burner, he had an objection to the burner being used to throw dust in the eyes of gas consumers and local authorities. The remark to this effect was vigorously assailed from all parts of the hall with cries of "No, no." Then Mr. Carr rashly provoked further contradiction by declaring that the burner had reduced the standard sperm candle to the level of a farthing dip. A smile flickered over the face of Mr. Charles Carpenter who was an interested listener from a seat just under the oil painting of Sir George Livesey. Mr. Carr knows that in this matter, he occupies a position of almost absolute isolation, and he declined to move an amendment to the report, as he wisely and candidly confessed that he did not think he would be able to carry it. Cause for unification of the standard burner was shown by the President; and there was no manner of mistake about the endorsement of the meeting when he remarked, "I am sure the Council have the sympathy of this meeting." Their object has been to do something to induce the Board of Trade to promote legislation to gain a desirable object; and there is no intention on the part of the Council of the Institution—either alone or in conjunction with the Gas Companies' Protection Association—to promote a Bill. Issue with Mr. Carr was joined by Mr. Walter Grafton over the "farthing dip;" and then the report was adopted.

The meeting enjoyed the little intervention by Mr. Carr; and thereafter the members prepared themselves to approve—and this they did very handsomely—the choice of the Council in the matter of the awards of medals for the papers read last year. Mr. Harold Woodall must have felt, by the applause that accompanied him to the platform, that there is a wide appreciation in the profession of his work, in collaboration with Mr. A. M'D. Duckham, on continuous carbonization in vertical retorts. To him the "London" gold medal was awarded for the paper he read last year; and with a characteristic trait of those whom we all know of the same cognomen, he gave a full share of the honour to Mr. Duckham. The influence of the paper on "Refractory Materials" that Mr. F. J. Bywater read at the meeting a year ago bids fair to be lasting and widespread, by the fillip it has given to investigation into the rational and scientific treatment of refractory materials; and Mr. Bywater deserved all the good things that were said of him by the President, as well as the tangible recognition of the Institution silver medal. The meeting thought so too. Then Mr. Hayman was called up to receive the Institution bronze medal for the paper he read last year recounting the progress made with the Dessau vertical retort system in Germany; and generous indeed was the applause. While he prefers to regard the award as a mark of appreciation

of the work done in Germany in connection with the vertical retort system, the members feel their indebtedness to Mr. Hayman, as well as to his chief, Mr. E. Körting.

The Presidential Address.

The interesting item of award presentations having been disposed of, the President was again on his feet. There was generous applause. The most critical time and act in the presidential year are always accounted the occasion and delivery of the presidential address. The reception of the members can give heart or otherwise. If it were required, it would have had the former effect on this occasion. The President's style and delivery were excellent; and meaning was greatly enhanced by his well-chosen emphasis and by clearness of tone and pronunciation. There was an impressive silence indicative of the deepest sympathy as the President read the terms of his appreciation of the life work of Sir George Livesey—whose death, unhappily, marks the past year. He sketched the attributes that culminated in the high position Sir George attained in the gas industry long before he went to his final rest. Co-partnership received the President's encomiums for its several and generous effects; and, all present knowing Sir George, were in acquiescence with the remark that Sir George's own wish would have been that his life's work should be remembered by no other scheme than this. The reasons for the original introduction of the system the President finds are not so weighty now as then; but he might have gone farther and said that, in the gas industry, this is largely due to the battle waged against the tyranny of militant labour organization at the time of the inauguration of the scheme in its primitive form. But the President rightly sees that there are other reasons now existent as weighty as those that then prevailed, for bringing the interests of the workers into closer identity with the business that gives them employment. Among those that he enumerated is not found the spread of the vicious and disturbing doctrines of Socialism. That is an oversight. The Livesey Memorial Fund, and the purposes to which it is to be applied, were touched upon in manner approved by the hearers. To traverse this and other parts of the address, however, is quite unnecessary. The text of the deliverance was published last week; and what may be regarded as—touching upon the future of the industry—the chief considerations to be drawn from it are treated upon in our editorial columns this week. On the technical and commercial necessities of the future, the address was full of thought; and in the former connection the President gave the members the first account of his working at Norwich with the three-feet high horizontal chambers (with a carbonizing capacity of 21 cwt.). When the President remarked upon gas-works becoming the centres for the preparation of smokeless fuel both for industrial and for domestic uses—solid and gaseous—of the future, there was laughter at his manifestly intentional humorous suggestion that a hard-pressed Chancellor of the Exchequer should consider the question of taxing consumers of the bituminous coal, gas-works excepted. The figures he gave as to the ratios of day to night consumption of gas are worthy of the closest study. The proportion the day gas business has now assumed to the whole is truly remarkable; and in Norwich, Great Yarmouth, and possibly many other places, there is little doubt that we are within measurable distance of the old order of things being completely reversed, and the day consumption exceeding the consumption of the hours of darkness. Possibly, too, as Mr. Glover said, at the present time, in Norwich, less than 10 per cent. of the gas is used in feeding luminous flames. Of 28,000 houses in the city, 20,000 have cooking-stoves fixed in them. The rate of progress in the fixing of appliances in which gas is used for heating is shown by the following figures for 1907: 1104 cookers, 841 fires, 116 geysers, 728 boiling-rings, and 77 grillers. Is it to be marvelled at that the President is looking forward to the time when the illuminating power standard will be superseded (if we are to have a standard of quality at all) by a calorific power one. Interest in the various other themes was sustained to the very end; and when the final words came: "May we blithely go to our business all the day, and come to our resting-places weary and contented and undishonoured," there was an outburst of applause from the packed audience—an audience surely unexcelled in numbers at Institution meetings—that in itself was more eloquent than the richly-deserved compliments that fell from the lips of Mr. William King and Mr. J. Horsley Palmer (Chairman of the British Gaslight Company and of the Imperial Continental Gas Association), and Mr. H. E. Jones, in proposing, seconding, and supporting respectively the vote of thanks. It is rarely that a President has, on such an occasion, the felicity of hearing, as did Mr. Glover, an expression of appreciation from his own Chairman, with such qualifications as Mr. Horsley Palmer possesses in eminent degree as an experienced gas administrator. Few and modest were the words of the President in acknowledgment of utterance, and of the ratification of the members.

Livesey Memorial Fund—£10,154 Subscribed.

Three weeks age we appealed in the "JOURNAL" for the filling up of the Livesey Memorial Fund by the opening day of the annual meeting; and this was supported by a letter from the President in the following issue. In the course of his address, the President was able to announce that the fund had reached the sum of £9970 16s. 7d. The announcement was heartily cheered; and a little later Mr. H. E. Jones made himself personally responsible for the balance if it did not come in before the close of the meeting. Still later in the morning, Mr. C. F. Ruggles (President of the Eastern Counties Association) announced that he had been authorized by the members of the Association to say they would be pleased to augment the fund by 20 guineas. But though the minimum amount the promoters of the fund originally set out to obtain is in hand, there is no official announcement that the fund is closed. There have, of course, been incidental expenses attached to its promotion; and there is no reason whatever why the fund as it stands to-day should not be substantially augmented by those who still desire to subscribe.

Following the President's address, and an announcement as to the position of the fund by the Hon. Secretary (Mr. S. Y. Shoubridge), Professor Arthur Smithells, as representing the University of Leeds, spoke of the honour the authorities there feel that the University has been selected as the place in which the memorial to the lost leader of the industry is to be set up, and of their determination to do all in their power to make the memorial worthy of the great man whose memory it is to perpetuate.

On the last day of the meeting, it is convenient to mention here though out of chronological order, the President announced that the fund had reached the sum of £10,154. There were hearty cheers. He also made it clear that the fund is still open; and that the £10,000 named is merely the minimum sum required.

Gas-Fire Efficiency.

Appropriately the first technical matter to engage attention after the presidential deliverance was the report of the Gas Heating Research Committee, the Institution members being Messrs. John Bond, J. H. Brearley, and Charles Wood, in association with Professors Arthur Smithells (Chairman), William A. Bone, and Julius B. Cohen, of the Leeds University, and Mr. E. W. Smith, M.Sc., as Research Chemist. Mr. Smith represented the Committee on the platform; and, in fact, the larger portion of the report that he had to present is from his pen. As the members were fully aware, the object the Committee have had has been to make a scientific investigation of the efficiency of the gas-stove as a heating appliance, and to ascertain the facts in regard to certain hygienic questions that arise in connection with heating by gas. An inquiry such as this demands an immense amount of preliminary work. But in this report we have now some definite results; and it appears from it that the Committee are fully justified in the tribute they pay to the skill in the experimental work of their Chemist, who, by the way, succeeded Dr. Drugman. After hearing or reading the report, the hope expressed by the Committee that the work may be continued cannot be otherwise than heartily supported. There are several suggestive courses in which further research can be profitably made—such as the efficiency of different kinds of burners and arrangements of radiating materials (their composition, size, thickness, and shape), the methods for securing ventilation, and a few others are presented in our editorial columns.

Mr. Smith did not read his report; but he gave a sketch of its contents, illustrated by numerous lantern slides. In what he had to say, there was much that is not included in the report proper. For instance, he outlined the work of, and results obtained by, Dr. Drugman in connection with condensing gas-stoves. But the investigation is incomplete;

and it has been deemed advisable to defer publication until the matter can be put into more definite form.

There is much in the printed report connected with the description of the methods adopted in the experimental work that will not greatly appeal to the majority of gas engineers and managers, beyond giving them the assurance that some attempts (although all may not commend themselves) have already been made to ensure accuracy in the results. The introduction to the report, if somewhat elementary in certain of the initial explanations, is useful for giving to it completeness. One point is the criticism of the misuse of the word "radiator" applied to certain well-known types of gas-heaters. These appliances should, the Committee remark, be more correctly termed "convectors." It is really a small point on which to lay hold. The term "radiator," if a misnomer in its present application, is one that appeals to the general public; whereas the term "convector" would have no, or little, meaning to the public. In the application of the nominal term "radiator," it is more a descriptive trade expression than anything else. It is agreed with the Committee that there is a widespread and deeply-rooted belief that a gas-fire, even if satisfactory as a radiator, is necessarily attended by some hygienic disadvantage. "If the radiating efficiency of gas-stoves can be materially improved, and if it can be shown that a gas-stove, when properly constructed and used, has no more deleterious influence than a coal fire, a great advance will have been made towards the substitution of gaseous for solid fuel as a means of domestic heating." The report of Mr. Smith goes a good way towards showing these points; and he gives for the first time a tolerably correct absolute measurement of the radiating power of a gas-stove. The open gas-fire with which he experimented consisted of seven bunsen burners all connected with the same air and gas supplies, which were adjustable. The fire-clay front measured 9 in. by 9 in. The average consumption was 17 cubic feet of a gas of a net calorific value of about 142 calories (571·4 B.Th.U.). The details of the experiments may be bye-passed in this brief reference to the report. Suffice it to say that, under the conditions of the experiments, the amount of energy radiated from the stove lay between 30 and 33 per cent. of the total energy generated by the stove. Of this about 25 per cent. was radiated above the floor-level. In one experiment, a reflector was placed at the foot of the stove; and the amount of the energy radiated above the floor-level was increased to 28·6 per cent.

Among the indications of the experiments are that either the front of the fuel should be much thinner, in order that it might attain a higher temperature, and therefore emit more radiations, or that it should be made more open, and the back of the stove more compact, so that more direct radiations would be sent into the room. It is also interesting, as showing the value of the maintenance of the house-flue in connection with gas-fires, that the temperature of the products of combustion, on leaving the stove, varied with the volume of air passing through the stove-flue. Should the house-flue be closed except for the stove-pipe, the suction on the stove-flue will be very great, and the flue loss of heat correspondingly high. Should, however, the house-flue be open and the stove-flue about 4 feet long, with its entrance restricted, there will be a smaller volume of air passing through the stove-flue, but an increased ventilation up the house-flue. It was stated by Mr. Smith that the amount of air passing through a stove has no marked effect on the radiations into the room. With regard to the preheating of the gas, it is remarked that there is no reason why it should not enter the bunsens at the temperature of the escaping products of combustion (90° to 100° C.). Of course, some proportion of the heat will always be required for the purpose of carrying away the waste gases; but 3000 B.Th.U. per hour is looked upon as excessive. There is an account given as to the experiments regarding the vitiation of the atmosphere by carbon dioxide from gas-fires. But the general findings from the experiments will prove the most attractive of all points in the report: (1) The total radiation from an open gas-fire is about 32 per cent.; and this is unaffected by the amount of ventilation through the room. (2) No carbon monoxide escapes under ordinary conditions into the room; and very little is ever found in the flue. It is only when the flame is interfered with that there is any. (3) About 30 per cent. of the heat generated in the stove passes directly into the flue. This figure varies with the volume of air passing through the stove-flue. (4) There is no necessity for products of combustion to enter the room and cause discomfort. (5) Reflectors may be usefully employed to produce a sensible increase of radiation into the region where it is most wanted. There is ground for satisfaction in these conclusions; but they show that there is a big margin from which to secure for the user of gas-fires a greater degree of heating efficiency.

The Report Criticized.

The report, as the President said in opening the discussion, gives a pretty good indication of what the Research Committee are doing; and he and many others hoped the Special Purposes Fund of the Institution would be maintained in a position to persevere with this and much other work. The speakers in the discussion were Mr. John Bond, Mr. H. James Yates, Mr. J. H. Brearley, Mr. James W. Wilson, Mr. H. Kendrick, Mr. Alex. Wilson, Dr. A. H. Elliott (New York), Mr. Walter Grafton, and Professor Smithells. It will be seen from these names that the excellent course has been continued by the Council of the Institution of inviting manufacturing representatives interested in particular subjects to take part in their discussion. Naturally, the debate ran over much ground; and there was a considerable amount of criticism, which to do it justice, as Professor Smithells remarked, required a studied reply. Several of the submissions by the reporter were challenged, and certain matters otherwise criticized. The room in which the tests are being made came in for a bad handling. It was described as box-like; and the point was made that it did not comply with the normal conditions under which gas-fires are used. As to the amount of air passing over the fire, the President holds that the pull on the chimney must seriously affect the radiating value of the fire. But Mr. Yates tells us that a fire can be constructed in which a large amount of air can be carried over the top of the refractory material without interfering with the heat, and without any possibility of carbon monoxide escaping. Curious is Dr. Elliott about (in the report) a missing one-third of the heat produced by the combustion of the gas in the fire. He finds from the report that one-third is radiated into the room, and one-third goes up the chimney; but he looks in vain in the report for the other one-third. There is disagreement regarding the point as to getting the radiation from the fire high up into the room; the most useful place for it, the practical gas man points out, is at the floor-level. Again, no products of combustion are wanted in a room; and if there are any, then the fire is not correctly constructed or used. Proper maintenance is insisted on before the winter season commences as the best means of preventing complaint.

Some interesting figures were imparted by Mr. Bond as to the cost of a given amount of radiation. Coal fires, he submits, cost less than gas-fires; while electric radiators come off a bad third. It would appear that gas has not much to fear from electricity as a heating agent. The figures (which will be found in the full report of the discussion) as between coal and gas fires were challenged in relation to useful heating effect. It was thought that comparative tests of coal and other fires which would appeal to the public would be of advantage. But Professor Smithells points out that the Committee want to elicit facts on scientific lines, and not merely to produce arguments for adoption by a reluctant public. It seems to him the time has come when, instead of relying upon the persuasive arguments of the makers of fires and the ill-considered statements of medical men, there should be scientific facts available to support the position of gas as a heating agent. The manufacturers assert that they are, and they offer evidence in support, engaged in doing their best by research and so forth in improving their fires apart from the work of the Committee. This is satisfactory; but the point is submitted that it is not right, in view of the great expense to which they are put in securing the development of a high state of efficiency, for gas suppliers to go too much for cheapness. Research, improvement, and cheapness will not run together. It is to the interest of both the gas suppliers and the fire makers to supply an efficient article. Mr. J. W. Wilson wants a place to which gas-fires can be sent for testing; and a certificate awarded if the fires succeed in reaching the standards laid down. It is suggested by Dr. Elliott that, if gas is used to heat water, and the water is employed for heating rooms, a great deal more useful heat can be got out of the gas than by using it for heating under present methods. It is possible to get no less than 80 per cent. of the heat units of the gas into the water. The heating apparatus, however, would

be very expensive. The question of humidity was also touched upon.

With the discussion on the Gas Heating Research report, a long sitting ended. It was much after two o'clock before the remnant of the members rose. The meeting had grown somewhat thin. Sheer weariness (not with the quality of the subject-matter before the meeting, but the length of the sitting) and inner cravings were the causes of departure.

Meeting on Wednesday morning, the first matters to be considered were the affairs of

The Benevolent Fund.

There is nothing much to say about this. The report has been published; but the President remarked upon the aid that is being rendered to the fund by the affiliated District Associations—an incentive to this having been the lead given by Mr. Charles Meiklejohn in connection with the Midland Association. Mr. Thomas Bower and Mr. Hubert Pooley were added to the Committee. The rules were also altered so as to give the District Associations a greater identity and interest in the working of the fund. In future, the Hon. Secretaries of the affiliated District Associations will take part as members in the work of the Committee. It is an excellent arrangement.

Apologies for Absence.

It was with regret and sympathy that the members heard that Mr. Corbet Woodall, through a slight accident, was unable to be present at the meeting; and that arrangements for a trip to Canada on professional duty prevented the attendance of Mr. Thomas Newbigging, the President of the Society of British Gas Industries. It was, however, with gratification the members heard that Mr. Newbigging was able to undertake the journey.

The remainder of the sitting was devoted entirely to the question of carbonization; and there is no doubt, from the large attendance throughout, that of all technical topics this is the one that has foremost thought in the minds of the profession at the present time. The whole of the matter presented, and the discussion, show that we are passing through a very live period of change in carbonizing practice, and also that opinion is about as unsettled as it can possibly be. In the first place, there was circulated a report by the Carbonization Committee; and the papers read in succession, before discussion, were by Dr. Rudolf Lessing, on "Carbonization in Chamber Settings," by Mr. J. Ferguson Bell, on "Carbonizing," and by Mr. Robert Watson, on "Some Advantages and Disadvantages of a Hot-Coke Conveyor."

Registering Carbonizing Progress.

The Institution are under much indebtedness to Dr. Rudolf Lessing this year. In addition to his paper treating of "Carbonization in Chamber Settings," he, at the request and under the direction of the Carbonization Committee, prepared an epitomized record of the new carbonizing work that has been done in this and other countries during the past twelve months. The members would have had a more comprehensive survey at the hands of the doctor had there been more time between the request made to him and the date by which the report had to be available for presentation. The record shows enormous development in the application of the Dessau intermittent system of carbonization in vertical retorts, and in the use of chamber settings in Germany and other countries abroad. So little do German gas-works think now of the ordinary horizontal and inclined systems, that the contractors for carbonizing plant will not say much about them; but they are all now putting their energies into either vertical retorts or chamber settings. The Dessau type of vertical setting, being the first in the field, has obtained a larger adoption than the competitors; but it has had the advantage of some active promoters, who enjoyed the technical and financial support of a powerful group of industrialists. It is, as Dr. Lessing points out, significant that of about 4022 retorts erected, or under construction, on the Dessau system, about 1000 have been to the order of a single company. A statement recently issued by Mr. Edward Körting, with reports by Messrs. Prenger and Weiss, indicates that the Dessau retort has a durability of 900 to 1000, and even more, days under fire, after which probably only the lower part of the retort requires renewal. Lightly touching upon the controversy as to the preferable practice of admitting steam into vertical retorts or water gas made in separate plant, Dr. Lessing makes no statement as to his own views on the subject.

In this country, there has been slower progress in the application of vertical retorts, due to the ambition of British engineers to effect continuous charging and discharging, to which the vertical retort specially lends itself. "Considering all the factors involved, and in view of the wider experience gained, it must," says the report, "be admitted that this principle is not only a perfectly sound one, but it appears to be preferable to that of the intermittently charged and completely discharged retort, both from theoretical and economical considerations." The extent of adoption in this country of the vertical system so far is easily put on record: Ten beds of sixes on the Dessau system are now being erected at Sunderland. Of the Woodall-Duckham system, nine settings of four retorts are going in at Burnley, ten settings of four retorts at the Kensal Green Station of the Gaslight and Coke Company, four retorts are in use at Nine Elms, and there are the settings at Bournemouth. Oversea, an installation is being erected near Chicago to test local coals; and the system is also in operation at the Lyons Gas-Works. A setting (equal to 20 tons a day) on the Glover and West continuous system is in daily use at St. Helens. In other directions, Mr. W. R. Herring is at work on a setting at Edinburgh, to allow at will of continuous or intermittent operation; Mr. Alex. Wilson, at Glasgow, is also experimenting; and Messrs. Dempster and Sons are at work on a setting at Cleethorpes. The report includes a test at Nine Elms with the Woodall-Duckham setting on 61·39 tons of coal; the make being 12,839 cubic feet per ton of 15·2-candle power gas, and a net calorific power of 509·7 B.Th.U. The Glover and West system, using slacks of local coals, gives results of 11,500 to 11,800 cubic feet of 16-candle gas of a net calorific power of 530 to 540 B.Th.U., with a very low fuel account and a dry coke. "The good results," remarks Dr. Lessing, "seem to be largely due, quite apart from the continuous system involved, to the very excellent heating horizontal compartments, which permit of a convenient and independent adjustment of the temperature of the retorts at every height." The report touches upon the President's three-feet chambers, carrying (twelve-hour) charges of 21 cwt., yielding, with Yorkshire small coal, 12,300 cubic feet of 15-candle gas of 500 B.Th.U., and superior coke, with the other products up to satisfactory figures. Mr. Alex. A. Johnston is also conducting experiments at Brentford in inclined chambers, with charges of 15 to 25 cwt. Considerable interest attaches to these trials, as attempts are being made to guide the travel of the gas through the charge in a direction most conducive to obtaining a high quality by providing a vertical partition wall, which, by means of suitable recesses, collects the gas in the centre of the charge. Love's 45° inclined retorts are not forgotten; but Dr. Lessing does not supply any fresh results. Another distinctive feature of carbonizing practice in this country has been the charging of ordinary retorts fuller; and by this means some of the results of vertical working have been secured.

It is considered that the adoption of carbonizing chambers abroad is the most important event in the carbonizing branch of the gas industry during the year; and it is remarkable how they have taken possession of technical fancy in Germany and elsewhere. Most of the German carbonizing plant erectors now have designs of their own; and the results of the working of those so far in operation appears to be approximately of the same character—about 12,000 cubic feet of gas per ton of a net calorific value of 550 B.Th.U., but of poor illuminating power. The coke is not much inferior to the metallurgical variety; and a fair yield of ammonia is combined with the production of a light tar containing very little free carbon. The report briefly marks much progress. It also contains references to retort-house machinery, to low-temperature carbonization, and to the instructive researches by Mr. R. Forbes Carpenter into the latest carbonization systems.

Carbonization in Chamber Settings.

Hopes were not falsified in the paper on "Carbonization in Chamber Settings." The British gas profession has been placed in possession, through the "JOURNAL," of a considerable amount of information on the subject; but this is the first occasion on which it has been brought directly before the Institution or any other of our home societies. The author of the paper—Dr. Rudolf Lessing—although he cannot claim to be a designer of, or practical worker with, these settings, has made such an extensive study of

them at the scene of their birth, through the published information concerning them, and personal inquiry, that he is able to speak with some authority. He spoke well; and his reasoning is such that one inclines to a ready acceptance of, at any rate, the theoretical argument through its very lucidity and apparent soundness. The argument from the practical point of view is another matter. But before he finished his paper (which was illustrated by numerous lantern slides), Dr. Lessing made it abundantly clear that he is not an advocate for any precipitate adoption of this system of carbonizing; he rather appeared before the members as a chronicler of events, with the view of stimulating enterprise and progress. Nor did he advocate any particular system of chamber settings; he treated all of which he had knowledge with frank and absolute independence. In fact, so far from thinking the chamber system has attained to the title of perfection, he makes a suggestion which may prove an inspiration to those interested in continuous carbonization in vertical retorts, and result in a trial being made of continuous gravity or mechanical charging in conjunction with large-bulk chambers.

Before the author concluded, he produced sufficient evidence to indicate that chamber settings have already reached a degree of working adoption on the Continent that shows that many gas engineers have been attracted by them. But the peculiar thing is that, although they have done so, they cannot be in any better position than Dr. Lessing for forming judgment; and he candidly confesses, despite his study of the system, that he is not in a position to submit that sufficiency of material and working results, which he considers to be desirable, and indispensable evidence in forming a conclusive opinion for or against the change. A passing tribute to coke-oven workers, a reference to disadvantages and advantages of coke-ovens from the gas maker's standpoint, and an allusion to some casual remarks of Dr. Bunte as to the possibilities of carbonization in larger bulks for gas-making purposes (which remarks served as the inducement to the subsequent work by German *confrères*), led up to an account by the author of the development of what are nominally known as the Munich chambers, as designed and put into practical work by Mr. H. Ries, in collaboration with Dr. Edward Schilling. First 1 ton inclined chambers; and then 2·2 tons, with subsequently a bench on larger scale of fifteen chambers in five settings. These have been in continuous operation at Munich since Oct. 6, 1906. A diagram is given in the paper by Professor Bunte, which affords a good idea of the general course of carbonization in these chambers. The average illuminating power of the gas is low—only 10 to 12 candles; but the calorific power is about 560 B.Th.U. A remarkable feature is the high candle power at the commencement of carbonization and then its rapid fall, and continuance at a low level. The charges, of course, are comparatively few, with a consequent saving of labour, and smaller losses of gas upon charging and discharging, in comparison with small charge working as in ordinary practice. In plant with larger carbonizing capacity, the contrasts in these respects will be all the more striking. In the Hamburg settings, the charges average 17·5 tons per setting of three chambers; the yield of gas (English coal) being about 12,500 cubic feet per ton. An astonishing point, considering the construction of the settings, and the large masses of cold coal dumped into the chambers, is the lowness of the fuel consumption—12 to 15 per cent. of the coal carbonized. And this seems to be confirmed by varied experience. In new works that he has constructed, Mr. Ries has built a bench of six settings of three chambers, and increased the capacity per setting to 19·4 tons. A second bench of the same capacity is in course of erection. The increased carbonizing space is obtained by lengthening the chamber to 28·7 feet, corresponding to 23·4 feet on the horizontal. The charging and discharging arrangements are generally described by Dr. Lessing. On the Munich system settings are nearly completed or under contract with a total carbonizing capacity of upwards of 1500 tons per twenty-four hours at Leipsic, Paris, Rome, Berlin, Hanau, Ratisbon, and Munich.

Turning from the Munich construction, particulars are supplied of the Koppers settings at the Bochum gas-works; a notable point being that the output per man per shift is stated to be 100,000 cubic feet. A battery of fifteen chambers has been erected at Vienna, carbonizing about 120 tons per twenty-four hours. Occupying a total area of 7000 square feet, 200 cubic feet of gas are made per square foot covered. The yield of gas per man employed, per shift of eight to ten hours, equals upwards of 175,000 cubic feet. Knoch's inclined chambers with vertical heating flues are alluded to; there being in this plan of construction absolute independence of each chamber. Klönne's inclined, horizontal, and vertical patterns are also noticed. At Königsberg, four of these inclined chambers have been erected; and the carbonizing wages are said to have dropped from 9d. with inclined retorts to about ¾d. per 1000 cubic feet with the inclined chambers. The Klönne horizontal chambers at Rotterdam, described by the Engineer in our columns last December, are also referred to; as is a vertical setting of five chambers at Dortmund. A vertical chamber oven of Messrs. Horn's design has been started at Hecklingen. A complimentary allusion is made to the work of the President at Norwich and to that of Mr. A. O. Jones. When Dr. Lessing passed from purely descriptive work, and a statement of the advantages and disadvantages of the chamber system, to the theoretical aspects of carbonization in bulk and the course of the process of the carbonization as mentally pictured by him, he was at his best; and we will not attempt to put into few words that which contains so much interest as it stands in the form in which he presents it in the paper—largely assumptive though it be.

Carbonizing Experiments at Derby.

Succeeding the account of work on chamber settings, Mr. J. Ferguson Bell was called upon to read his paper on "Carbonizing." Mr. Bell has been reconstructing the carbonizing plant in one of the retort-houses at the Litchurch station of the Derby Gas Company; and it will be seen from the paper that in the new bench of eleven settings of eights, 22 in. by 16 in. by 18 ft. throughs, he has incorporated several of the latest approved practices for securing good returns, together with one or two ideas that are not perhaps so commonly approved. He has adopted 8-inch ascension pipes on one side of the retorts only. Each of the dips is fitted with Simmonds patent anti-dip valve. There are separate gas take-offs foreach setting; the gas-valves are fitted with Drory indicators; and the tar is removed by the now well-known Dillamore tar columns. Carpenter's retort-house governors control the suction on the 18-inch foul main. The quantity of carbon formed on the inside of the retorts worked with anti-dip valves is less than half that formed on retorts worked with light seals; and up to the present time there has not been a single stopped pipe. A De Brouwer projector and a Jenkins De Brouwer pusher are used, with a De Brouwer hot-coke conveyor.

The costs of working quoted by the author are actual over six months' operation, including everything for eighty retorts, from coal unloading to coke store or hopper. Small coal and slack are generally used. When working six-hour shifts, 6 cwt. charges are put in; eight-hour, 8 cwt. charges; ten-hour, 10 cwt.; and twelve-hour, 12 cwt. With the projector no difficulty is found in putting in heavy charges of 12 cwt.; and these Mr. Bell finds will push out almost as easily as the lighter charges, provided the coal is properly carbonized. The cost for carbonizing (including all retort-house labour) is for six-hour charges 7½d. per ton, and for eight, ten, and twelve hour charges 6¼d. Working the whole bench (eleven beds), the cost for six-hour work is under 7d., and for the longer and heavier charges 6d. per ton.

The paper is packed with details and figures, for which reference must be made to the original on other pages. But just a glance at the carbonizing results, as the author has made numerous experiments with both light and heavy coal charges to ascertain in which direction the maximum benefit in gas and residuals is to be obtained. In these trials he has only used seconds or ordinary Derbyshire coal, with good rough Derbyshire coking slack added; and the class of coal must be considered in making comparisons. With the heavier charges, a denser and improved quality of coke is obtained, that is particularly suited for trade purposes. The tabulated figures show that the quantity of large coke increases with the weight and duration of the charges, and that there is less breeze made; but these heavier charges of longer duration somewhat increase the fuel account. In regard to ammonia, the slower carbonization tends to augment the production; there being an increase of over 17 per cent. between charges of six and twelve hours' duration. With heavier charges of longer duration, too, the quantity of tar produced is greater, and found to be lighter and much thinner; and, in addition, the gas leaving the condensers carries a larger quantity of light tarry matters forward to be removed by the tar-extractor.

The figures as to gas made indicate that so far as total sperm value is concerned, it makes little difference whether the coal is carbonized during six, eight, ten, or twelve hour periods. With the lighter charges and shorter time of carbonization, the quantity of gas made is less, but the candle power is higher; and with the longer periods the make increases while the candle power decreases. With six-hour charges (average weight, 6 cwt. 20 lbs.), the gas made per ton corrected was 10,594 of 16·31-candle power, tested by the "Metropolitan" No. 2 burner; with eight-hour charges (average weight, 7 cwt. 3 qrs. 12 lbs.), the gas made per ton was 11,245 cubic feet of 15·59-candle power; with ten-hour charges (average weight, 9 cwt. 2 qrs. 17 lbs.), the make was 11,499 cubic feet of 14·53-candle power; and with twelve-hour charges (average weight, 11 cwt. 2 qrs. 4 lbs.), the make was 11,463 cubic feet of 14·77-candle power. The paper includes some tests with eight-hour charges of high-class Yorkshire silkstone coal. The experiments clearly indicate that heavy charges with longer periods of carbonization tend to give higher and better results from the coal, more especially in regard to the yield of bye-products. Mr. Bell's trials in this respect cover much ground, and exhibit the care and thoroughness invariably associated with the work he undertakes.

Hot-Coke Conveying, and Its Advantages.

The application of material handling machinery in gas-works has spread with considerable rapidity, not only through the larger works of the country, but down to works on a lower level in point of capacity. In the use of hot-coke conveyors, how low in works' productive capacity can we profitably go? This was the point brought up for consideration in the paper submitted by Mr. Robert Watson. From carbonizing to the transit of the spent charges from the retort-house is a gentle descent. The author's contention is that the line of profitable application of conveyors is lower than many are disposed to think. Discussing the economic possibilities of such plant, the indirect advantages, as well as the direct charges, have to be considered—the former including the quickening of retort-house operations, facile stacking, and applicability to screening methods. As a matter of fact, in small works, the full value of the conveying plant is more easily appraised from the point of view of the coke yard than from that of the retort-house. The preparation of coke for the various needs of home consumers is in these days essential to its disposal, and for the avoidance of cut-prices and the annual losses that cut-prices occasion. To stimulate local trade in broken coke, a coke-breaking plant, elevator, screen, and hoppers were required at Doncaster; and the question was whether the coke should be conveyed to the plant by barrow or conveyor. After duly weighing the *pros* and *cons*, a West combined coke conveyor and screening plant was adopted. Apart from the monetary point of view, the advantages, as seen by Mr. Watson, are humanitarian, the accelerating of charging operations by the rapid removal of the coke, the obviating of the tendency with the use of coke-barrows to lessen the weight of the spent charges by placing less coal in the retorts, as well as the avoiding of light charges in the bottom retorts owing to the difficulty of filling the coke-barrows without spilling, and the work of clearing up. The wear and tear of plant, breeze, and coke saturation by water, are the disadvantages; but Mr. Watson shows, by his own experience, that a limit can be placed on these. All were experienced by him at Doncaster at the outset; but they have been reduced, and the conveyors are now working under normal conditions and satisfactorily. For details of how this has been brought about, there must be reference to the text of the paper.

The question of breeze is an important one; and to this the author devoted some attention. He maintains, and rightly, that a properly constructed conveyor *per se* does not increase the breeze production to any serious degree. It is the treatment subsequent to the conveyor that is in fault; but this can be largely minimized by simple means. Taking barrowed coke thrown out in the usual way, and coke collected at the end of the inclined section of the conveyor, he found the breeze from the barrowed material equal to 4·6 per cent., and from the conveyor 6·5 per cent. Then subsequent to the head of the conveyor incline, the substitution of one steep shoot by three shoots arranged so as to allow the coke to slide, reduced the total percentage of breeze from 10·1 to 7. Therefore, between the two methods of transport, there does not appear to be a great deal of difference; and if coke-breaking is resorted to subsequent to either method of conveying, the breeze produced must have approximate correspondence. Still, he admits that the excess is sufficient to cause trouble on some works. The percentage of breeze wheeled, broken, and screened is 7, as against 8 when mechanically conveyed and screened; and therefore, in the handling of 12,000 tons of coke based on 22,000 tons of coal carbonized per annum, the difference between the tonnage of breeze is as between 840 and 960. On a basis of 22,000 tons of coal carbonized per annum, Mr. Watson puts his costs, including loss due to excess breeze, at 7·64d. per ton of coal. Taking credit for the increased value of (say) 2000 tons of domestic and smithy coke at 1s. 3d., equalling 1·36d. per ton of coal, the total cost for conveying and screening is brought down to 6·28d., as against 6d. for conveying only. As the plant can deal with more coke, it is expected there will be a proportionate drop in the costs with the increasing output of the retort-house. The costs per ton of coal carbonized for wheeling, breaking, and screening, amount to 9·28d. Taking credit as before for the increased value of 2000 tons of domestic and smithy coke 1·36d., the total costs are reduced to 7·92d.; while for wheeling only the costs are 6·78d. Judged by these costs, the gain by conveyor removal is not great; but the small profit shown, added to the important advantages indirectly accruing to retort-house working and to the men, would, the author contends, justify the use of a conveyor in comparatively smaller works than those of Doncaster. The results, when the effect on the disposal and sale of coke is taken into consideration, are much more decided. The difference in favour of the full conveying and screening plant, as compared with barrow wheeling and separate breaking and grading appliances, is as much as 1·64d. per ton of coal carbonized. The withdrawal of surplus coke from the outside market to be sold, through proper preparation for use, at full prices in the home district is also a point to be taken into account.

The Discussion.

Many men, many views. But it cannot be said that some of the remarks in the discussion were altogether pertinent to the cardinal features of the papers. There was really too much matter over which the members could rove. An important question was asked by Mr. Charles Hunt. It was as to whether the report of the Carbonization Committee represented the whole of the work done by the Committee during the year. A reply was given in the negative by the President, who explained that the Committee had not been idle; and the report merely embodied their views. Supplementing this, Mr. Shoubridge mentioned that, in the present inconclusive state of experience with the newer systems of carbonization, the Committee had thought it advisable not to expend money in their direct investigation until matters were in a more settled condition. Those who took part in the discussion were Mr. Charles Hunt, Mr. Edward Allen, Dr. Harold Colman, Mr. J. P. Leather, Mr. A. T. Harris, Mr. A. F. P. Hayman, Mr. H. Townsend, Mr. T. Canning, Mr. H. W. Woodall, Mr. W. H. Y. Webber, Mr. E. A. Harman, Mr. J. H. Brown, Mr. H. E. Copp, Mr. J. G. Tooms, Mr. W. H. Morgan, Mr. S. Y. Shoubridge, Mr. T. S. Lacey, and Dr. Elliott.

It was soon seen that, with so many forms of carbonization for gas production in existence, there are no very settled views on the subject. Engineers are somewhat embarrassed and perplexed over the position with which they are confronted. Not many tackled the question of the carbonizing chambers. But it is clear that up to the present British gas engineering notions have not advanced far on the road of preference to large bulk carbonization. There is no question that Mr. Irving fairly reflects the views of many in saying that it cannot be the correct system of working to place a large bulk of coal in a chamber, and let it distil there for four-and-twenty hours; and he shows his preference for something of a more continuous nature. In this, Dr. Lessing is not at variance with him. Naturally the illuminating power curves of the gas from the chambers proved striking. Illuminating power must continue an important factor in this country, so long as it is the parliamentary standard. If we were under a calorific power test, the poor illuminating power of the gas from chamber settings would not weigh so heavily in the balance against them. Quite the most informative speech on the papers was that of Dr. Colman. It was, in fact, a miniature lecture. The manner in which the first volatile products travel, and how they are subjected to heat in their travel, through the coal and coke are points of great importance. In the newer developments of vertical retorts,

intermittent or continuous, and the larger bulk carbonization chambers, there are no doubt variations in the manner in which the volatile products course through the coal and the coke. The new systems do not yield the same amount of marsh gas as can be obtained in horizontal retorts; and this is accounted for by the fact that, in the former, the volatile products do not get heated to so great an extent in their passage, as they do in horizontals, in which, using the same coal, the percentage of marsh gas would be higher and the hydrogen lower. Attention was called in this connection to Dr. Bone's lecture of last year. In Dr. Colman's view, it may be regarded as reasonably probable that the cracking-up of the tars does considerably increase the percentage of marsh gas, and therefore this yields beneficial results. It seems to him that what we have to aim for is the cracking-up of the tars produced in vertical retorts and coke-ovens just to that extent where the tar gives off its maximum quantity of carbon to the gas, without, at the same time, increasing the amount of free carbon and naphthalene to an abnormal extent. That is the problem before us. It sounds very simple; but it will require a great deal of work ere it can be achieved. Some very practical points were made by Mr. Hayman, who has had an opportunity of studying large bulk carbonizing chambers at closer quarters than gas engineers in this country. The weight of the charges, and the amount of heated surface to which the gas is exposed, are not beautiful things in the eyes of most gas makers. The fuel account is high. The saving of labour too is annulled by the irregular quality of the gas, and the high capital charges. Mr. Canning also made the point that the use of such chambers is curtailed by the demand in a locality for metallurgical coke.

Turning to other salient points. The work that has been done at St. Helens with the Glover and West vertical retorts was sketched by Mr. John West; and Mr. Harold Woodall showed distinct gratification in having such an old carbonizer as Mr. West testifying to continuous carbonization being the proper thing. There is no doubt that the vertical retort has done much to increase our knowledge of what goes on in carbonization, and advantage has been taken of it in horizontal work. As Dr. Colman aptly says, the advent of a new system in any industry usually helps to make the working of the old system better. The use of heavier charges in horizontal working is one result of the coming of the vertical retort; and Mr. Bell was heartily congratulated on the results he has secured in this way, and which results Mr. Shoubridge was able to confirm. It shows there is something in the old horizontal retort yet.

On the question of coke transport, there was not much discussion. Mr. Watson's contribution suffered by being tied up with carbonization; but it was a sacrifice to time. There was confirmation as to the dropping of the coke after it leaves a conveyor, and not the conveyor itself, being the most guilty in the matter of breeze production. Two or three speakers testified well to the telpherage system of coke handling.

Thursday morning first thing the benches were sparsely occupied; but the President took this quite good-naturedly, in view of the excellence of the attendance the previous two days. A little later, however, the numbers were largely augmented; and there was again a good audience.

Calorific Value and Mantle Efficiency.

There was a large amount of interest attaching to the first paper by Mr. Arthur Forshaw, M.Sc.—interest which will be variously described as academic or practical according to the amount of personal attraction that the subject has for those who look into it. It is well that such research should be carried out as that in which Mr. Forshaw engaged, on his selection for the Institution Research Fellowship in the Department of Gas Engineering and Fuel at Leeds University. Wrong theories and notions may have long sway unless they are proved by someone competent to be erroneous, or at all events until some investigator of sufficient competence challenges their correctness. In the paper there is much that is of practical directive importance. The communication is entitled "A Comparison between the Illuminating Efficiencies of Carbon Monoxide and Hydrogen when Used in Conjunction with the Incandescent Mantle;" but in one respect it is, in effect, a challenge to the belief that has become somewhat prevalent that the illuminating efficiency of a combustible gas—be it coal gas, water gas, or natural gas—used in conjunction with an incandescent mantle, is proportional to its net calorific value. The basis for this belief appears to be the investigations carried out by Messrs. White, Russell, and Traver in 1901-2; and more recently by M. Sainte-Claire Deville in 1907. The conclusions arrived at by these investigators were much on the same lines. Mr. Forshaw, however, found it difficult, on *à priori* reasoning, to attach any physical meaning to the supposed simple connection between the calorific value of a gas and its illuminating efficiency, whatever view is taken of the cause of luminosity of the mantle.

With few exceptions, the comparisons made between the illuminating values of various gases and their calorific powers have had reference to more or less complex mixtures of gases; and the results of such experiments as have been instituted with single gases, or with mixtures of two gases, are precisely those which do not conform to the conclusions drawn from the more complex gases. Thus the desirability of a careful series of comparative experiments being made with one or two gases in a state of purity appealed to Mr. Forshaw; and for this purpose hydrogen and carbon monoxide seemed to possess qualities which eminently fitted them for such a comparison. The two gases are similar in having nearly the same net calorific values, and also in requiring exactly the same proportion of oxygen (or air) for their complete combustion. Here, however, their similarity ends; and they differ in two important respects—in density and "combustion intensities." The density of carbon monoxide is fourteen times that of hydrogen; and not only is the rate of combustion of hydrogen known to be very much higher than that of carbon monoxide, but their rates are unequally accelerated by the influence of hot surfaces. This reminds of the lecture delivered recently by Professor W. A. Bone before the North of England Association of Gas Managers. However, under the circumstances, it was decided to make a systematic investigation of the mantle efficiencies of these two gases; and the conditions requisite for the attainment of the maximum illumination from each, with a view to determining whether, with two single gases having nearly like calorific values, but exhibiting considerable differences in the character of their flames and modes of combustion, the supposed dependence of illuminating effect upon the calorific values could be verified.

Then Mr. Forshaw placed before his audience the preparatory work associated with the experiments, following with the results that he obtained under different conditions, as well as the effect of using cones in the burner, after the manner suggested by Messrs. Cash and Eady [" JOURNAL," July 14, 1908]. In all the experiments in the paper in which hydrogen and carbon monoxide are compared under similar conditions of aëration, the advantage is overwhelmingly in favour of carbon monoxide. The maximum duty obtained for hydrogen at a consumption of 9·13 cubic feet per hour was 11·76 candles per cubic foot—a result which has to be compared with 17·33 candles per cubic foot obtained for carbon monoxide, at a consumption of 7·69 cubic feet an hour. These results show a 48 per cent. margin in favour of carbon monoxide; while a comparison of their calorific values, as used in the test, shows only a 13 per cent. advantage in favour of carbon monoxide. Among other conclusions, it is found that, when hydrogen is burned in an ordinary atmospheric burner, with the highest possible degree of aëration with such a burner, the duty afforded steadily decreases with a rising rate of gas consumption. It is also seen that the distribution of luminosity over the mantle with such a burner is vastly different with hydrogen than with carbon monoxide under similar conditions. It is found, too, that the use of cones inside the mantles causes a quickening of combustion and concentration of illumination. There was acknowledgment by Mr. Forshaw to Messrs. George Bray and Co. for the interest they had taken in constructing the burner used in the experiments, and to the Welsbach Company for their interest in making the mantles.

The Discussion.

Communications were read by the Hon. Secretary on the subject of the paper from M. Sainte-Claire Deville, Professor Bone, Mr. Vernon Harcourt, and Mr. J. W. Bray. Remarks were contributed by the President, Mr. Thos. Holgate, Mr. Leon Gaster, Mr. J. P. Leather, and Mr. James Paterson. M. Sainte-Claire Deville does not think the results obtained by Mr. Forshaw, when properly examined, disclose very much difference between them. Support was given to Mr. Forshaw's conclusions by Professor Bone. He contends that mantle efficiency results depend upon other factors besides

the mere calorific value of gas; but the precise definition of these other factors must be left for future inquiry. It was pointed out by Mr. Vernon Harcourt that a property other than calorific value in relation to mantle efficiency is the rate of combustion. The greater the rate of combustion, the higher the temperature of the flame. Mr. Bray remarked upon the construction of the burner being a highly important matter in dealing with two different gases. If Mr. Forshaw had changed his burner, he might have obtained a nearer approximation between the illuminating power of hydrogen and carbon monoxide. Among the speakers the same view was held. In using a gas like hydrogen, both a special burner and mantle should be constructed. However, with the complimentary remarks made both by correspondents and speakers Mr. Forshaw must have been highly gratified. Much importance is attached to the fact that a commencement has been made in this country in the scientific investigation of illumination with incandescent mantles. It is very acceptable to have fundamental data relating to distinct gases; and it is thought that such work will assist in assessing the value of different gases obtained by the new systems of carbonization. Certainly, the examination of simple gases in this manner will put us in a better position to know what to aim for in carbonization. The highest mantle efficiency corresponds with that gas which has the highest flame temperature, said one speaker; and another enlarged this by observing that it is important in incandescent lighting to pay attention to both the shape and intensity of the flame. It is considered by Mr. Leather that Mr. Forshaw has in his conclusions stated things which are not borne out by facts or experiments—particularly in regard to surface contact in quickening combustion. Mr. Paterson fails to see that putting a cone into a flame can increase combustion; but different results might have been obtained if the cones had been made hollow, and of thin substance, so as to have prevented the absorption of any heat. It is hoped that the investigations will be continued—especially in connection with the inverted burner, which has developed a higher efficiency than the upturned burner from the complex gas supplied by the town-gas maker.

Sympathy.

Mr. R. Forbes Carpenter, the Chief Inspector under the Alkali Works Regulation Act, is well known to many of the members of the Institution. He has within the past few days suffered great bereavement through the loss of his wife. The members know the Chief Inspector as their friend; and, on the proposition of Mr. Charles Carpenter, seconded by Mr. Samuel Glover, the members placed on record their deep sense of sorrow with Mr. Forbes Carpenter. Mention was also made of the serious illness—happily the worst has passed—of Mrs. James Whimster, of Armagh, which prevented Mr. Whimster's attendance at the meeting.

Statistical Studies.

Statistical exercises do not supply the most attractive or thrilling of material to put before a gathering of men at the last sitting of a three days' meeting; and subject and period in the proceedings therefore combined to lessen the attendance which Mr. Herbert Lees and Mr. Arthur Valon well deserved for their instructive compilations in the matter of statistics peculiar to the gas industry. Mr. Lees' paper was a "Study in Working Costs;" and it was thoroughly done, within limits. Those who desire to sell gas cheaply cannot neglect to study costs, item by item. Every item from coal to consumers' appliances for which money has to be spent by a gas undertaking, every piece of plant and every appliance, and every method involved in the manufacture and distribution of gas, all have their distinctive effects on working costs. The gas engineer requires the eyes of Argus. It is good, says Mr. Lees, for an engineer not only to make comparison of his own with another's work, but also to carefully note the progress of his own undertaking year in year out. Granted; but, in all such comparisons, geographical and local conditions have to be taken into account before complimenting oneself or becoming depressed over a condition of one's circumstances that, with all endeavour, will not attain a uniformity with the concern with which comparison is made. Mr. Lees makes his study over the area limited and defined by "Field's Analysis." The lessons to be extracted from the well-known "Analysis" are good; but it must always be borne in mind that dealing year by year with the same, and in number a moderate, set of undertakings, the "Analysis" has set upon it a limited significance. There is danger in conclusions drawn from averages; but the object of the author's study is to see, within the confines of his survey, the trend of working costs in quinquennial periods over some five-and-twenty years, ending with 1907. These years have been very live ones in the gas industry; and they compass the period of (in large part) the introduction of gaseous firing, the coming of the incandescent mantle, cooking-stoves, the prepayment meter system, &c.

The fuel account claims first consideration. Mr. Lees at once finds himself faced with the difficulty of unreliable information. There is so much estimating about the quantity of coke and breeze used for fuel, and so little accurate measurement; and, in the estimates between works and works, there is in consequence considerable discrepancy. But assuming the method of calculation adopted throughout by the compilers of "Field's Analysis" has been consistent, evidence is found by the author of progress in fuel economy; and this progress is sure to become more general. Taking next the figures as to the make per ton for the four groups of concerns treated in the "Analysis"—Metropolitan Companies, Suburban Companies, Provincial Companies, and Provincial Corporations—between the years 1883 and 1907, they disclose "substantial progress." Not such progress, however, as published high makes have led one to fully expect. But we are dealing with averages. In the case of the Metropolitan Companies, the progress in average increased make, in the 25 years, with a make of 10,885 cubic feet per ton in 1907, is 610 cubic feet; the Suburban Companies, with 11,169 cubic feet per ton in 1907, 956 cubic feet; Provincial Companies, with 10,457 cubic feet per ton in 1907, 344 cubic feet; Provincial Corporations, with 10,827 cubic feet per ton in 1907, 1069 cubic feet. The last-named have made most progress, but only because their make in 1883 was as low as 9758 cubic feet. The Provincial Companies have effected the least progress in this regard; and their average make in 1907 is the lowest. New carbonizing principles and methods, in addition to higher temperatures, have come in of late years to improve working accounts in this respect. It should be noted, however, that high makes per ton are not everything; other considerations have to be taken into the calculation. It may be very economical to purchase a local low gas-yielding coal, with in the end a profit comparing with the best.

The author cannot say much about coal and residuals; these being dominated by market fluctuations and local influences. Coming to working expenses, the total per 1000 cubic feet of gas sold has increased in the case of the Metropolitan Companies between 1883 and 1907 by 1·45d.; and in the case of Provincial Corporations by 0·50d. The Suburban Companies exhibit a decline of 0·15d. and Provincial Companies of 1·13d. Wages have been an important factor in this increase, notwithstanding the introduction of machinery. If, however, manufacturing charges (apart from coal) be taken, it is seen these have been reduced in the case of the Metropolitan Companies by 2·35d. per 1000 cubic feet; in the Suburban Companies, by 3·11d.; in the Provincial Companies, by 1·76d.; and in the Provincial Corporations, by 0·72d. Though the Provinces show a smaller decrease in this respect during the period, it is because their figures were lower in 1883, and are still the lowest in 1907. One notable and gratifying point in the author's comments is that the introduction of additional machinery has not added to the cost of wear and tear; the item being less than formerly. It is not surprising to find that the economies gained in other directions are cancelled by increased expenditure in the distribution department. The item of rates and taxes shows an increase of nearly 50 per cent. in the case of the Metropolitan Companies; the Suburban and Provincial Companies have maintained a very regular figure throughout; and the Provincial Corporations have an increase of 40 per cent. The author makes a remark emphasizing what has before been pointed out, that this 40 per cent. does not indicate that, where sums are extracted from municipal trading undertakings in aid of the rates, the rates are lower than where there is no such source of income for the local exchequer.

The net cost of gas into the holder per 1000 cubic feet sold has decreased all along the line, excepting in the case of Provincial Corporations, who show an increase of 0·76d.; but they come out second lowest in the list of costs with 11·89d. per 1000 cubic feet—the premier position being occupied by Provincial Companies with 11·32d. Other charges, principally distribution, have nullified the advantage gained in the net cost in the holder. Between 1883

and 1907, the net cost and working expenses per 1000 cubic feet of gas sold has increased in the case of the Metropolitan Companies by 0·80d., Suburban Companies by 0·02d., and Provincial Corporations by 1·98d., while the Provincial Companies have decreased by 3·09d.—placing them in a superior position, with 17·15d. per 1000 cubic feet. Capital charges, however, is a field for exploitation; and in the 25 years, the Metropolitan Companies have reduced their capital charges per 1000 cubic feet of gas sold by 4·67d., the Suburban Companies by 6·18d., the Provincial Companies by 3d., and the Provincial Corporations by 3·87d.—the total of the capital charges in 1907 being respectively 10·40d., 9d., 7·79d., and 6·29d. Day gas consumption, and the lower rates at which capital can be obtained by gas companies, are largely responsible for this reduction. The average net gas-rental has in the period been reduced to in the case of the Metropolitan Companies (in 1907) 30·34d., Suburban Companies 31·83d., Provincial Companies 22·77d., Provincial Corporations 26·16d.—the reductions being respectively 6·43d., 9·83d., 7·62d., and 3·14d. It will be noted that the average net rental of the Provincial Corporations in 1907 was higher than the Provincial Companies by 3·39d.; it must not be overlooked that the Corporations occupied a better position in 1883 than any of the other groups of undertakings. In the raising of capital, too, they have occupied an advantageous position. But the difference is becoming less; and while the Provincial Companies show a steady reduction in capital charges, the Corporation charges appear to be on the increase. Averages are all very well from which to draw general deductions; but the ideals that are to be adopted are beyond the best individual records under an approximately like set of conditions. Mr. Lees does not desire his paper to be taken as anything more than an attempt to mark progress. The result of his study is encouraging; and prospects are shown to be distinctly hopeful.

The Capital Account.

Has not the time arrived when an effort should be made to enable gas companies to reduce their capital accounts? This question is the essential feature of the final paper presented by Mr. Arthur Valon, which, though short and last on the list, is in its matter of immense importance. He makes suggestions to the end in view; but he does not submit them as being the best, but merely propositions. In leading up to his point, he does not—and this was recognized by the meeting—take up any partizan or dogmatic attitude, or point the finger of scorn at one class of undertaking, because, under its conditions of working, the average capital per million cubic feet of output—regarded from the point of view of the average of the whole—is higher than in the case of the other class of undertaking, nor does he enter into the vast field of explanation that is necessary to show the wherefore of this.

Admittedly, it is, at the first blush, startling to find that the total capital raised, per million cubic feet of gas sold, by statutory companies is £822, while the total money borrowed by local authorities, after deducting sinking fund and loan repayments, amounts but to £457. Examination of details, however, shows that the figures are not strictly comparable owing to stock conversions in the case of companies, and the amount paid upon transfer by local authorities for goodwill. The total of the amounts paid for goodwill upon transfer cannot be obtained without a large amount of unprofitable research; but the average of sixteen of the largest undertakings amounts to £137 per million cubic feet of gas sold upon the existing consumption. Looking at the table accompanying the paper, it is remarked that the net capital outlay in the case of the companies has steadily fallen from £675 to £610 per million cubic feet of gas sold, while, in the case of the Corporations, the total amount of money borrowed per million cubic feet fell until 1897, when it stood at £616. It has since risen to £639; but if allowance be made for the increase at the time of transfer, the figure would be lower than the net capital outlay of the companies. Since 1891 the capital cost per million cubic feet of increase has been greater in the case of local authorities than in that of companies, due to the proportion of expenditure in slot installations that the latter wisely charge to revenue. But the ultimate point of consideration is that there is now a difference of £153 per million in the net capital of the local authorities and the companies to the advantage of the former; and a difference of £309 per million between the outstanding loans of the local authorities and the capital of the companies upon which dividend or interest has to be paid.

This being the position, the direction in which an effort should be made by the companies to reduce their capital is, Mr. Valon submits, by redemption. That is the only way. There is precedent in the Gaslight and Coke Company; but this Company is in an altogether exceptional position in respect of its capital account, owing to amalgamations and the abandonment of intown stations. However, it was in 1903 that the Company were restricted from paying any increase of dividend above the standard until they first placed a definite sum to a fund for the redemption of capital—the fund being formed by money the Company might otherwise have divided as increased dividend. Such a process must, if generally applied, of course, be safeguarded by limitations. How the sums should be appropriated are discussed in the paper; and how the sums set apart for redemption should be applied is also considered. These are all details, however, merely supplementary to the main idea of redemption. It is not possible to settle any detailed scheme; and as to the objections of present shareholders and consumers, this is a point that should be considered in the light of the concluding words of the paper: "A low capital account is so obvious an advantage in the struggle with our competitors—a struggle which is likely to be even keener in the future than in the past—that some present sacrifice would surely be justified in order to obtain it."

Assent and Dissent.

In the discussion Mr. Lees' paper was, unfortunately, almost neglected; and on Mr. Valon's paper, there was, as might have been expected there would be, a division of opinion as to his central suggestion. The speakers were Mr. Edward Allen, Mr. D. Irving, Mr. D. Vass, Mr. John Carter, Mr. J. P. Leather, Mr. D. T. Livesey, Mr. A. Yuill, and Mr. J. H. Brearley. In a very few sentences, the trend of the discussion can be indicated. There was some talk of Mr. Valon's paper suggesting that the gas industry is a dying one. That Mr. Valon repudiated. All sorts of objection was raised to the suggestion of a regulated capital redemption fund for gas companies. It is thought that it would be against the interests of present consumers and shareholders. The price of gas would have to be raised; and this would be detrimental both to the present and future of the undertakings—particularly in the case of the smaller companies. In short, the cure would be worse than the disease, if so the capital position of companies can be called. The favourable position of gas stocks in the market is considered to be an argument against any such scheme being necessary. On the other hand, there were speakers who agree that a redemption fund would strengthen the position of gas companies. Middle courses were suggested—such as greater recourse to revenue for improvements, and so keeping down capital expenditure. It was also suggested that greater reserve fund powers are required. Needless to say Mr. Carter hardly thinks justice is done to municipalities in connection with their trading undertakings, and that they do not receive the impartial treatment they deserve. In his opinion, the suggestion is significant that such a drastic change as Mr. Valon recommends is necessary to put the affairs of gas companies in as sound a position at those of municipalities. Mr. Valon points out that if gas companies had a redemption fund, it would only be equivalent to the sinking fund of municipalities.

Pipe Thread Standardization.

Mr. James W. Helps, who attended the recent Paris conference on pipe screw-threads, handed in a report on the subject. This is reproduced in the general report of the proceedings. He acknowledged the indebtedness of the Institution to the British Engineering Standards Committee for the great assistance they rendered at the conference.

The New President.

Though a foregone conclusion, there was much enthusiasm on the announcement that, as a result of the ballot Mr. James Helps, the Senior Vice-President, was to pass to the highest seat of honour in the Institution. Mr. Alexander Wilson, of course, succeeds to the Senior Vice-Presidency; and Mr. Robert G. Shadbolt takes rank as the Junior Vice-President.

Next Year's Meeting.

There was some discussion as to the place of meeting next year. It is suggested that Leeds should be selected. There are reasons for. The Institution is to have a closer association with the Leeds University; and the endowment of the Professorship in Gas Engineering and Fuel is an event of the year. A small, but still a further consideration is that in the Leeds Gas-Works, the new President (Mr. Helps) spent the early years of his connection with the gas industry. Again, the University, through Professor Smithells, gives the Institution a cordial invitation to the city. There are reasons against. All going well, in the succeeding year, the Glasgow Corporation Gas Committee will, with Mr. Wilson, be issuing an invitation to the members to assemble in that city; and there is a large proportion of the members who find London so convenient, that they do not look with pleasurable anticipations to meeting away from the Metropolis two years in succession. The matter was left with the Council to settle; but the meeting gave them a clue to their preference for London.

New Honorary Members.

The President of the Société Technique and of the German Gas and Water Association were added to the long roll of honorary members.

Then we came to the final business. There was a perfect shower of votes recognizing services rendered to the Institution during the year and at the meeting. Many appreciative words were uttered regarding the President and others; and they were in their very fulness richly deserved. They formed an appropriate conclusion to an annual meeting highly favoured from many points of view, and one ranking with the foremost of its predecessors in point of success in work and result.

SOCIAL EVENTS OF THE WEEK.

After the cold and wet days that London had been experiencing immediately before the meeting of the Institution, there is ground for hearty congratulation that, with the opening of the sittings, the weather generally put on better behaviour, and there was improvement quite to the close of the week, by which time it may be said the weather was brilliant in comparison with what it had been. In consequence, the visit to the Metropolis was thoroughly enjoyed. It is one of the attractions of London to our provincial friends and their ladies that there is so much to do and so much to be seen there—no matter the prevailing climatic conditions. Yet we must give one and all their due. Providing the proceedings for the discussion of the prosaic matters of technical and commercial concern do not occupy the whole time, the members are, as a rule, punctilious in observing their duties in this respect, and we accept this as evidence that the ladies do not seek to entice them from the main object of the visit.

Masonic.

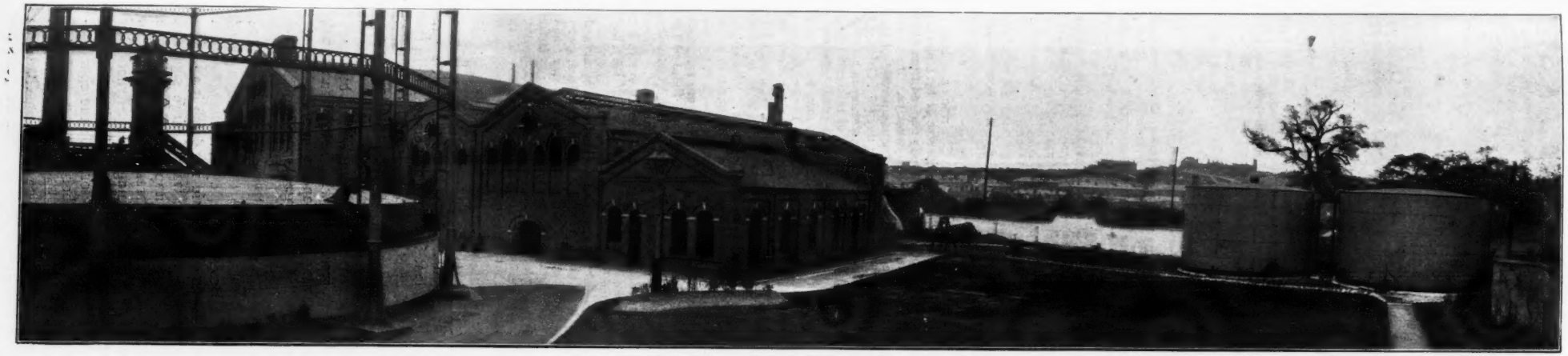
Maintaining custom when the Institution of Gas Engineers have their annual conference in London, the Evening Star Lodge (No. 1719) arranged on Monday last week to hold an emergency meeting, so as to offer a welcome to the members and their masonic friends. The gathering took place at the New Gaiety Restaurant, Strand, and was largely attended—there being some 142 present. The W.M. (Bro. Jacques Abady) was in the chair, and was supported by his Wardens, W. Bro. W. A. Surridge and Bro. Cyril Davis. In the course of the evening, Mr. John Terrace, Engineer and Manager of the Great Grimsby Gas-Works, was initiated; and at the close of the ceremony, W. Bro. A. E. Broadberry, P.M., of Tottenham, delivered the customary charge. The subsequent proceedings included a banquet, followed by a selection of vocal and instrumental music—arranged by a Committee consisting of the W.M., the Secretary (W. Bro. W. D. Child), W. Bro. Arthur Valon (Director of Ceremonies), and W. Bro. Walter T. Dunn.

Reception and Dance.

It is appropriate that the reception by the President and his wife should come early in the week's doings. There seems a little unfitness about an event of this kind occurring when the programme for the week has been half passed through. On this occasion, the President and Mrs. Glover departed from what has grown almost the custom of having the reception on the Wednesday evening, and did quite the correct thing in receiving the members and their ladies on the evening of the opening day of the meeting. The splendid and convenient galleries of the Royal Institute of Painters in Water Colours were again chosen as the scene of an evening of social and merry event. When it is stated that the guests of the President and Mrs. Glover numbered no less than 330, it will be recognized that the latter had a busy time during the period of the reception from eight to nine. But the smiles and heartiness of the President, and the smiles and grace of Mrs. Glover, convinced their numerous guests and friends that they were deriving considerable happiness from the position in which they found themselves. Among the guests were Mr. and Mrs. Dugald Clerk and the Chairmen of the Sections and the Secretary of the Society of British Gas Industries. Mr. Dugald Clerk is the Vice-President of the Society. There was much regret that the President (Mr. Thomas Newbigging) could not be present. However, we are glad to see the interchange of courtesies between the Institution and the Society. May it long continue. That by the way, however. The guests quickly spread themselves about the rooms, and were soon engaged in admiring the pictures, in friendly discourse, in listening to the music, and those who delight in the whirl and pleasures of the dance were busily occupied in the pleasant task of securing their partners. The programme of music under the direction of Mr. Arthur Barlow was an excellent one; and as vocalists, in company with him, were Miss Florence Holderness, Miss Ethel Bevans, and Mr. Henry Plevy. Their songs and madrigals were much admired. After the reception, the guests were constantly on the move between the music, dance, and refreshment rooms. Not until about a quarter of an hour before midnight did the last of the guests depart, filled with most pleasant recollections of the evening.

At Norwich, and on the Bure and Wroxham Broad.

After work, play. Friday morning, there was great bustle around the entrance to No. 8 platform at the Liverpool Street Station of the Great Eastern Railway from just before 9.30 to 9.50. There was Mr. Dunn and his courteous and ever-willing assistant dispensing, next to the ticket examiners, place tickets for a luncheon and a booklet giving succinctly an account of the sights of Norwich—the "sights" including the gas-works—and simultaneously they were also kept busy answering the thousand-and-one inquiries, more or less necessary, of a number of inquisitive excursionists. We must, while we think of it, give Mr. Dunn his due. During an Institution meeting, there is not a single man who is harassed so much as he. Not only does all the detail of the meeting fall upon his shoulders, but he is supposed to know everything, and is plied with innumerable questions, many of them having very distant relation with the work and duties of his office. But he keeps a clear head all through; and when he has not a ready answer (which is seldom the case) the courteous word generally leaves the questioner under the impression that he has obtained all the information he requires. On this morning, the sight of the Secretary reminded one of all sorts of interrogations. But eventually the whole throng of 250 or so excursionists were aboard the special, and were soon on their way to the grand old city of Norwich. It was a great homegoing for the President and Mrs. Glover, accompanied by such a number of friends, among whom they had been the central figures in London during the week. An excellent idea was the making of the excursion on this occasion to the scene of the President's daily work, and enjoying its hospitality and beauties. There were a few who shook their heads when they heard of the proposal to go such a distance for the excursion. But in the event it was found that the idea was very popular; and those who undertook the arrangements for the day soon discovered they had taken on their shoulders a bigger task than they had bargained for. For the President's sake, however (such is the reward of popularity) they counted the additional work but as an additional pleasure. The Board of the British Gaslight Company—the owners of the Norwich gas undertaking (over which the President presides as Engineer and Manager with such acknowledged ability)—took upon themselves the reception of the visitors and their entertaining at lunch; and in successfully carrying out their generous wishes, there must be special mention here of the work of the Secretary of the Company (Mr. A. W. Brookes) and the members of the President's own staff at Norwich, and particularly of



VIEW OF THE NORWICH (ST. MARTIN-AT-PALACE) GAS-WORKS.

his assistants, Mr. V. E. Harston, Mr. W. H. Wayte, Mr. C. G. Frost, Mr. W. H. Taylor, and Mr. F. H. Phillips. They marshalled the details of the work with such consummate skill, that there was nothing wanting; everything presented an air of completeness; and everything passed off during the day with something like mechanical precision. The same with the afternoon's arrangements for pleasure and sight-seeing which had been kindly provided by the Corporation and their officials.

Thorpe Station at Norwich was reached just before 12.30; and outside special tramcars were standing, by which the visitors variously reached Bishop Bridge Gas-Works or St. Martin-at-Palace works. Both works were fully described and illustrated in the "JOURNAL" for Sept. 19 and 26, 1905; and their interesting features were then given special prominence. But from the booklet placed in the hands of the visitors we may just refresh the memory of readers with the following outline sketch:

The gas first supplied to the city was made from oil, under a patent granted to Mr. John Taylor (a native of Norwich) in 1815. In association with a Mr. Martineau, Mr. Taylor constructed oil-gas works at Hull, Bristol, Leeds, Colchester, Leith, Bow, Whitby, and several other places.

The British Gaslight Company was established in 1824; and all the shares of the Norwich Gas Company were soon afterwards acquired. The progress of the Company's Norwich works in recent years can be judged by the following figures:

	Gas Sold. Cubic Feet.		Consumers.
1901	362,643,000	..	13,379
1906	468,522,000	..	23,132
1908	515,522,000	..	25,485

The works were remodelled in 1903-4. They occupy two distinct sites, at St. Martin-at-Palace and at Bishop Bridge. In addition to these works, the Company have central offices and show-rooms in the Market Place, and residuals works for the manufacture of sulphate and distillation of tar, at Great Yarmouth.

On the St. Martin-at-Palace site are situated the retort-house, containing two benches of retorts, with a gas-making capacity of 2½ million cubic feet. The settings are of ten ⌂ (with the exception of the three feet deep chambers), and are heated by Klönne regenerators; the stoking being done by West's compressed-air machinery recently supplemented by a combined De Brouwer machine. The latter machine is for charging and discharging the chambers, and for relieving the compressed-air machinery when the latter is under repair. The coal-stores have a capacity of about 7000 tons. The coal is received by water, and is discharged from lighters on the river by means of a powerful elevator, which delivers through an automatic weighing-machine on to band conveyors. The water-gas plant originally consisted of two of Messrs. Humphrey and Glasgow's sets of 500,000 cubic feet capacity each. No. 2 set was remodelled and enlarged to 800,000 cubic feet capacity in 1906; and No. 1 set is now being likewise remodelled. The blast is supplied from two Sturtevant fans and Marshall reciprocating engines; and these are being supplemented by a De Laval turbine blower.

The steam plant consists of three Lancashire boilers, two 26 ft. by 6 ft. 6 in., and one 30 ft. by 7 ft. 6 in.—the latter, being constructed with dished ends and corrugated flues, was installed in 1908. The coke plant consists of De Brouwer conveyors, and hopper stores. The surplus is delivered into a covered store. The power house contains one 75-horse power "National" and one 80-horse power Tangye gas-engines, air-compressor, and dynamo. The tar and liquor storage comprises two circular steel tanks above-ground, each of 100,000 gallons capacity. The workmen's rooms are provided with facilities for cooking, washing, bathing, and dressing. The gasholder on the site is used as a relief holder.

On the Bishop Bridge site are situated the exhauster, meter, and governor house, which contains a vertical exhauster set of 150,000 cubic feet capacity per hour, a horizontal set of twins of 60,000 cubic feet capacity per hour each, and a horizontal set of 40,000 cubic feet capacity per hour. The latter is used for carburetted water gas. There are three station meters, two for coal gas, and one for carburetted water gas, two district governors, and a complete set of valves for controlling the flow of gas to and from the holders. The purifiers comprise four boxes 30 ft. by 30 ft. by 5 ft. 6 in. of Green's type, four 20 feet square water-lute boxes, four 36 ft. by 24 ft. by 5 ft. boxes, also with water-lutes, the first eight dealing with the coal gas, and the four latter with carburetted water gas. The purification is entirely by oxide. The holders have a total capacity of 1,384,000 cubic feet; and the maximum gas delivery in 24 hours is 2,253,000 cubic feet. An additional holder of a million feet capacity is about to be installed. The laboratory and photometer room are completely equipped with apparatus for testing the gas for illuminating and heating value, &c., and for the checking of all raw material and products. The district workshops and stores form the headquarters of a large staff of outdoor employees; the shops being provided with the necessary apparatus and tools for the cleaning and repairing of cookers, fittings, lamps, &c.

On arriving at St. Martin-at-Palace works, the visitors found Mr. R. S. Gardiner and Mr. Leonard R. Wilkinson waiting to receive them in their capacity of representatives of the Board of Directors. Unfortunately Mr. J. Horsley Palmer, the Chairman, could not be present; and Mr. Corbet Woodall was detained in consequence of the effects of a recent slight accident in which he was involved. The London staff was represented by the Secretary (Mr. Brookes); and members of the Norwich staff were, of course, all there, and unremitting in their attention to the visitors. A large marquee had been erected for the purpose of the lunch on the vacant part of the works' site; and it was decorated with a refined taste that was very generally commented upon. When the Chairman (Mr. Gardiner) had taken his seat, it was seen that places of honour were occupied by Mr. and Mrs. Glover, Mr. Wilkinson, Mr. James W. Helps (the incoming President), and the two Vice-Presidents,

Mr. Alex. Wilson and Mr. R. G. Shadbolt. Mr. Charles Carpenter and Mr. H. E. Jones were also near the Chairman. The City Authorities were represented by the Sheriff of Norwich (Mr. A. G. Howlett), the Deputy Mayor (Alderman W. H. Dakin), the Chairman of the Executive Committee (Mr. F. C. Havers), Aldermen and Councillors of the chief governing body of the city, the Very Rev. the Dean of Norwich (Dr. Lefroy), the City Engineer (Mr. A. E. Collins), the Electrical Engineer (Mr. F. Long), the Water Engineer (Mr. W. H. Parr), and others. Altogether there were about 45 local guests; so that the company who sat down numbered just about 300.

The luncheon was an excellent and generous one, and well served; and after the long railway journey, there was no question about the guests doing full justice to the good things set before them.

Thanks having been returned by the DEAN OF NORWICH, the loyal toast was proposed by the CHAIRMAN; and then

The CHAIRMAN submitted "The Institution of Gas Engineers." In doing so, he said those who knew what a deep interest the Chairman of the Company (Mr. J. Horsley Palmer) took in the concern over which he presided with such wisdom and success, would recognize that only an unpreventable cause could have deterred him from being present that day. They were also sorry at the absence of Mr. Corbet Woodall. His presence would have been so very acceptable on this occasion. They regretted the unfortunate wound which he sustained in Denmark a fortnight or so ago, and which had disabled him temporarily. The good wishes of those present would go out to Mr. Woodall, for his speedy recovery from the mishap. He (Mr. Gardiner) was pleased to be in the privileged position of offering the Institution a hearty welcome that day on behalf of the British Gaslight Company, and of proposing success and prosperity to the Institution. It was thirty years now since he first became associated with the gas industry, and with it he had in one way or another been continuously connected. When one looked back, and considered the means and methods by which gas was produced and distributed, and when one thought of the improvements that had been introduced (say) even in the last ten years, owing mainly to the creative genius, application, and resourcefulness of members of the Institution, and, perhaps in some minor degree, to the support that had been given to their efforts by the directors of gas companies and members of corporation gas committees, one felt indeed that it was almost superfluous to wish success and prosperity to the Institution, which through various stages had now reached the position to which it was entitled as the premier organization of the members of the gas profession in Europe. It was indeed a very proud privilege to address any body representing all that was best in every sense of the word in the gas industry of Great Britain and Ireland. The members had that day been good enough to come from London to see the Norwich works of the British Gaslight Company, and to see what their able President [cheers] had the last few years produced in the way of bringing up-to-date the gas plant in the city. This being so, might he (the Chairman) take the opportunity of sincerely saying one word to the younger members of the profession, whom chance had placed in works of less importance, and works on which large sums of money for experimental and improvement purposes could not wisely or properly be expended. He (the Chairman) had heard on occasions like the present one disappointment and sorrow from visitors because their own surroundings did not give them the advantage of producing the best that was in them. He felt very strongly that—apart from the supreme source of contentment which all must derive from the feeling which could alone be produced under the circumstances in which one was placed—in the gas industry, with every kind of works and with every kind of plant, the engineer or the assistant who was doing his best to get the highest results and to produce standard gas at the cheapest cost, and who was doing his best to get down the capital per million cubic feet of gas sold, was doing just as much to worthily represent the Institution, and to further the interests of the gas industry, as he who had the good fortune to be in a modern works, or to build new works, and to work plant of the most modern description. There was only one more point to which he had time to refer, and that was the pleasure the Directors of the Company experienced in knowing that the members and officials of the Corporation of the City of Norwich were extending to the visitors generous, kind, and gracious hospitality. They were taking the visitors to view some of the beautiful and picturesque surroundings of the ancient city; and he should not be worthily representing the views of his colleagues on the Board of the Company, if he were not to say on this occasion that they lost no opportunity of impressing on their managers, and requested them, to carry out the feelings which they themselves entertained, that it was only by harmonious and friendly co-operation between those responsible for the health and comfort of the city and those who were responsible for the supply of such a necessary everyday commodity as gas—that, he repeated, it was only by sympathetic co-operation between the representatives of these two bodies—the comfort, the convenience, and the well-being of the community could be furthered. He coupled the name of the President with the toast.

Mr. GLOVER, in reply, said he felt very much the hearty manner in which the toast had been proposed and accepted. He hoped those present would forgive him for not making a speech on this occasion, as he had been doing so much speaking the last few days, and had had to undertake somewhat arduous duties on behalf of the Institution. But he could not allow the opportunity to pass without saying how much honoured the Institution were by having this invitation to visit Norwich, by the generous hospitality his Board had extended to the members and their lady friends, and by the presence there of the Sheriff of Norwich, the Deputy-Mayor, the Dean, Aldermen, and Councillors, together with the City Engineer who had very kindly taken the chief responsibility of the afternoon's programme. There were also present the Engineer of the successful electricity undertaking of the Corporation, the Medical Officer of Health, and other officials. There were usually profuse smiles when one mentioned electricity. In that city the officials of the electricity and the gas undertakings worked together most harmoniously. They recognized—he (the President) recognized—that there was a place for both. They were—both Electrical and Gas Engineers—putting the best possible into their several departments for the good of their respective concerns; and he was glad to say they were both successful. The electricity works of the city had been well-managed from the first—formerly as a company, and since as a municipal undertaking. And he was not surprised the people of Norwich were proud of the concern. But the diagrams and figures he had shown during the week in London proved that in respect of gas the present function was not a funeral service; they were there only because of the successful carrying on of the ancient Company in the ancient city.

Mr. LEONARD R. WILKINSON next proposed "The Visitors." He remarked that this was a red-letter day in the annals of the Company. That their guests had come so far in such great numbers was a great compliment to the Company; and it was one the Directors would not readily forget. It was of the utmost importance, and would be even more so in the future, that such companies as theirs and such corporations as that of the city should be friends. In the city, they had been friends in the past, were friends in the present, and would still be in the future. On behalf of his colleagues and himself, he might say they would leave no stone unturned to secure the continuance of these cordial relations for all purposes.

The SHERIFF (Mr. A. G. Howlett), in responding, said he was very proud that one of their citizens should be the President of such an important body as the Institution of Gas Engineers. Mr. Glover had been in Norwich for some years now; and, by his geniality and ability, he had won the appreciation and esteem of his fellow citizens. Although the Corporation and the Company were running rival enterprises, he was glad to think and believe that the relations of the two bodies were most cordial and friendly. Their President had said there was room for both gas and electricity. He did not think they were competitors in any sense of the word. The success of the Corporation electricity works had been due to the rivalry of the Gas Company; and he had no doubt the rivalry of electricity had spurred on the Gas Company.

Mr. F. C. HAVERS also made reply, and congratulated the members of the Institution upon having a President so able as Mr. Glover. He hoped the day would be far distant when Mr. Glover severed his connection with the city.

Mr. J. W. HELPS submitted the toast of "The Chairman and Directors of the British Gaslight Company." In the course of his remarks, he spoke of the enjoyment those present had already derived from their visit, and of that which he was sure they had still to derive. Speaking of their hosts, he said he numbered among his friends several of the Directors of the Company. Their Chairman that day (Mr. Gardiner) he honoured as a man who had done much for their industry in knitting together the ties of friendship between the gas men of this and other countries. Their friend, Mr. Corbet Woodall, was one of themselves; and Mr. Horsley Palmer, Mr. Wilkinson, and other members of the Board were known for their business qualifications. They owed their gratitude to these gentlemen; for they had not only given them an excellent President, but they had allowed the President to do his work in that capacity, throughout the year, in such a way as to redound to the credit not only of himself, but of the Company. When they found the Directors allowing their engineers a free hand to enter upon research work to further not only their own interests but those of the whole industry, they knew they had men who were solicitous for the highest welfare of the industry. One and all thanked the Directors of the Company for affording Mr. Glover the opportunity for carrying on the great work upon which he had embarked. Those present would wish him to thank the Chairman and the Directors not only for this, but for the most generous manner in which they had received their visitors that day. (Cheers.)

The CHAIRMAN acknowledged the toast and the kind expressions and hearty endorsement that had accompanied it. It had, indeed, given the Directors great pleasure to see the members there that day; and he hoped the day's proceedings would tend to do something to foster that cordial co-operation between the directors of gas companies, members of corporation committees, and gas engineers which was so necessary to the welfare of the industry as a whole.

There were a few minutes to spare for the professional men of the party to visit the retort-house to see two of the chamber-retorts discharged about which information had been given in the President's address and elsewhere in the proceedings during the meeting. They found everything precisely as described and illustrated in Mr. Glover's address. The chamber-retorts each carry a 21 cwt. charge; and the two charges seen were exceedingly well burnt off. The chambers, however, were somewhat hotter than usual, owing to the charges having been kept in (in order to allow those present to see the retorts discharged) some $\frac{3}{4}$ hour beyond the ordinary span of twelve hours. The charges, though the retorts were full—almost close to the top—came away clean. The great mass of coke was played upon by a water-hose; but, of course, the De Brouwer conveyor, not having been constructed for such bulks of coal, did not catch it all without a little shovel work. The coke was of large size, and fully complied with the description applied to it during the week. It was an exceedingly interesting demonstration. An opportunity was given of examining the construction of one of the settings, now being built; and of witnessing the working of the De Brouwer projector, with the charging-plate specially fitted for these chamber-retorts.

There was not much spare time to linger over the interesting and instructive demonstration. The programme had been arranged with very small loose ends of time between the

items; and the party were soon making their way to the station to reach Wroxham for the river trip. A few volunteered to remain behind as the launch accommodation available was only equal to 250; and those who deprived themselves of the treat had the satisfaction of being escorted by Miss Edith Collins, daughter of the City Engineer, round the City to see the sights. At the cathedral the Dean interested the party considerably by pointing out the historical features of the ancient edifice.

But our own interests were with the large river party. Several launches had to be requisitioned to provide accommodation for all. Those living at Norwich have been vastly favoured by Nature; and as the panorama of beauty passed before the eyes of the visitors a little feeling arose in one's mind that it would have been more charitable on the part of Nature if she had scattered her charms about the country rather more freely, and had not exercised so much power of concentration. Well, the River Bure was passed along; the launches all did Wroxham Broad; and we were getting to know something more than we knew before as to how many of the people of Norfolk, and those who visit the county, enjoy the hours of real leisure and recreation that come as the reward of industry, when the launches stopped at the landing-stage opposite the "White Swan" Hotel, Horning, and there tea was provided. Only forty minutes were allowed here; and it was not long before the big party were again seated in the launches, and on their way back to Wroxham, where the special train for London was timed to leave at 6.45. At the station, we bid—or as many as time would allow did so—the President "Good-bye." But he joined the train; and it was as he stood on the platform at the next station, and the train was passing out, that three rousing cheers were given him. So was brought to an end a presidential year that is fraught with much for the future of the industry, and with the end of the one a new presidential year commenced, in which the central figure will be Mr. James W. Helps, of Croydon. We wish him during that year the health that will be necessary for the duties before him; and in those duties and the work over which he will preside, all the success and pleasure that he himself could possibly desire.

On Thursday night Mr. W. J. Liberty, the Lighting Inspector of the City of London, met many of the members of the Institution by the Law Courts to inspect the new Graetzin high-power inverted lamp which had been temporarily put in position for examination by the Lighting Committee of the Corporation (see *ante*, p. 695).

GENERAL REPORT.

The Annual General Meeting of the Institution opened last Tuesday morning, at the Institution of Mechanical Engineers, Storey's Gate, S.W.—Mr. THOMAS GLOVER, of Norwich, the President, in the chair. There was a very full attendance of members, at which the President expressed his great satisfaction.

Confirmation of Minutes.

The minutes of the last annual meeting were taken as read, and confirmed.

Appointment of Scrutineers.

On the motion of Mr. ALEX. WILSON (Glasgow), Messrs. Thomas Berridge (Leamington) and Mr. W. S. Morland (Gloucester) were unanimously appointed Scrutineers.

The Annual Report.

[See "JOURNAL" for June 1, p. 574.]

The PRESIDENT said the annual report of the Council had been circulated; and he hoped it had been read by all the members, for it was becoming a more important document every year, as the work of the Institution increased. If any one had not yet read it, he hoped they would do so, as it contained the record of much work done during the past year—some of it very important. If it were agreeable to the meeting to take the report as read, he would move its adoption.

Mr. J. W. HELPS (Croydon) seconded the motion.

Mr. ISAAC CARR (Widnes) said he should like to ask a question before the report was confirmed, with reference to the paragraph relating to standard burners. It stated that the Council proposed, in conjunction with the Gas Companies' Protection Association, to promote a Bill in Parliament for the purpose of making the No. 2 "Metropolitan" burner the universal test-burner; and he wished to ask if the Council had considered what the ultimate result of the promotion of such a Bill would be to the Institution from a financial point of view. It was obvious that if such a Bill were promoted, it would be strenuously opposed by the authorities upon whom it was likely to inflict injury; and it would therefore involve a very large outlay. He should like to know what proportion (if any) of the expenses of such a Bill would come upon the Institution, because their funds (which were sufficient for their own ordinary requirements) would be very inadequate if they had to bear any considerable proportion of the expenditure on such a Bill. While he congratulated the Council on the report as a whole, he took very strong exception to this particular portion, and thought the Council would have been much better advised if they had adopted a policy of non-intervention, and let this matter take its own course. He had no particular objection to the No. 2 "Metropolitan" burner as a burner, or to any other standard burner; but he did object to its being made the means of throwing dust in the eyes of consumers and of gas authorities generally. ("No, no.") It reduced the standard sperm candle to a farthing dip, and a very poor one at that. They had it on the authority of the people who were promoting this Bill that the 14-candle standard was necessary for the industry; and now these persons told them that they were unable to make gas of so low a quality. It was a very great mistake on the part of the Council to interfere. He desired to express his disagreement with this part of the report. He should not, however, propose an amendment because he did not think he should carry it; but he would content himself with this protest.

The PRESIDENT did not think that Mr. Carr would have any considerable following in the meeting. He had raised this objection to the action of the Council in helping to promote the unification of the test-burner in this country. At present the methods of testing were various; and there was no real comparison of the quality of the gas as supplied in various towns. This was an attempt to unify the standards used—to get the Board of Trade sympathetic, and if possible to induce them to promote a General Bill, which would get the standard burner unified, and so prevent the confusion at present existing. He felt sure the Council had the sympathy of the meeting in thus attempting to straighten things out; and there could be no doubt it would be a great benefit to the industry if they could induce the Board of Trade to promote such a Bill. The Institution did not propose to incur any considerable expense in promoting such a measure, either by themselves or in conjunction with the Gas Companies' Protection Association. Unfortunately, they had not the funds for such work; but he could not see the slightest objection to their co-operating in this useful object to the full extent of their power.

Mr. W. GRAFTON (Glasgow) took exception to Mr. Carr's reference to the farthing-dip, and thought that everyone must object to being tied to a burner which did not give the true result.

The resolution for the adoption of the report and accounts was then put and carried unanimously.

Presentation of Awards.

The PRESIDENT said he had much pleasure in asking Mr. Harold Woodall to come forward and receive the "London" Gold Medal for the best paper of last year, entitled "Continuous Carbonization in Vertical Retorts."

Mr. HAROLD W. WOODALL (Bournemouth), in thanking the President and the Institution, said the paper was the record of the work in which he had the pleasure and honour of being associated with Mr. Duckham for five years; and he could not accept this medal without mentioning that gentleman, to whom any credit which might attach to the paper was equally due. Looking back over the work, there were a few "ups," and a good many "downs;" but they had always felt that they had the sympathy and encouragement of the Institution, and he thanked the members for this culminating proof of their sympathy.

The PRESIDENT next presented the Silver Medal to Mr. Bywater, for his paper on "Refractory Materials," which, he said, was having important results. The after-effects of the paper would last a long time. A Committee had been formed to work in conjunction with a larger Committee, to endeavour to standardize refractory material. They had all had experience—unfortunate experience sometimes—of the need for such a Committee.

Mr. F. J. Bywater (Birmingham), in returning thanks, said he had endeavoured to call the attention of the industry, and of engineers generally, to what he had always considered a most important matter; and he trusted the result would tend to bring about the straightening out which was essential to success. In so doing, they would obtain the co-operation of many other industries who were keenly interested, and also of manufacturers, who had received the idea of conferences with engineers very candidly, and had expressed themselves as most anxious to meet them in every possible way.

The President then presented the third prize to Mr. Hayman, for his paper on "Continued Experience with the Dessau Vertical Retorts"—perhaps, he said, the most important development in carbonization. The paper might have been somewhat overshadowed by the previous one on the same subject; but it was very important, and gave the subsequent experience at Dessau.

Mr. A. F. P. Hayman (Berlin) said he thoroughly appreciated the great honour conferred upon him, which was far beyond the merits of the paper; but he valued it as a mark of appreciation of the work which was being done in Germany in connection with vertical retorts. Last year they had the pleasure of welcoming in Berlin a great many of the members, who were able to inspect what was being done there, and to see the various developments of the gas industry in that country. He hoped the impression they received was that in Germany they were well to the fore in everything appertaining to the manufacture and use of gas. A further reason why he particularly appreciated this honour, was that it had given him an opportunity of attending another of their annual meetings, and of renewing his acquaintance with so many members of the profession.

The President's Address.

The President then delivered his Inaugural Address, which was given in the "Journal" last week (p. 698). At its close,

Mr. William King said he had been asked to propose a resolution, somewhat to his surprise, as he would have expected that it would be entrusted to someone more actively engaged in the industry; but he was quite sure it would meet with hearty acceptance. His only right even to be present was as an old member of the Institution or as a Director of one of the largest London Suburban Companies; but between directors, committee-men, and officers there should be the closest bond of union and sympathy, and possibly those who occupied the post of directors might be in a better position than others to sympathize with the anxieties of engineers if they had gone through the mill themselves. He had listened to many, if not all, previous presidential addresses; and he thought the older members would agree with him that they had never heard a more excellent one. When, in addition to the daily round of anxieties, which the President so cheerfully faced, but which they all knew were by no means trivial, he had been willing to undertake the anxiety and investigation necessary for the preparation of a presidential address, a very large debt of gratitude was due to him; and he (Mr. King) therefore proposed that the best thanks of the Institution be presented to the President for his excellent address.

Mr. J. Horsley Palmer said that he had been asked to second this motion, though he was not a member, and it was only by the kind courtesy of the Council that he was so frequently invited to attend the meetings. It was, however, a special pleasure to second the resolution on account of the intimate connection between the President and himself, as Chairman of the British Gaslight Company, of which the President was the most able officer. In listening to the address, there recurred to his memory many recollections of work abroad, because one engineer on his staff had just received a bronze medal. He much regretted that he would be unable to be present at Norwich on Friday to welcome the members; but he hoped they would have a hearty welcome by three Directors and the Chief Engineer; and he hoped they would have a happy day.

Mr. H. E. Jones desired to add the testimony, not of a director, but of a really hard-working engineer, to this vote of thanks. He was delighted to see in the chair a thoroughly practical engineer. He considered that in Mr. Glover they had a typical President, who had the whole of his work at his fingers' ends; and he therefore, as a fellow-worker, desired to support the resolution.

The resolution having been carried by acclamation,

The President, in responding, expressed his gratification that the resolution had been moved by his old friend and fellow Lancashire man, Mr. King, and seconded by the Chairman of his own Company.

The Livesey Memorial Fund.

Mr. S. Y. Shoubridge (Sydenham) announced that the subscriptions to this fund now amounted to £9970 16s. 7d.; and he hoped the small balance required would be made up before the close of the meeting.

Professor Smithells expressed his pleasure at having the opportunity of saying, on behalf of the University with which he was connected, how much honoured they felt by being selected as the place in which the memorial to the great leader they had recently lost was to be set up. This was the first opportunity he had had of speaking at any of their meetings since the profession had determined how to carry out this memorial; and he did not like it to pass without assuring them how much the University appreciated the compliment paid to them, and how determined they were to do all they could to make it worthy of the great man whose memory it was to perpetuate. The words contained in the President's Address on the whole subject of the relation of scientific teaching at the University to the profession of gas engineering, left nothing to be said by him; for anything more discriminating or more just it would be impossible to put together. He only hoped the views he had expressed might be seconded in the minds of all belonging to the profession. If they were, he had no fear at all for the future. That they had great difficulties to face, he did not attempt to deny. They had a new enterprise to conduct; but if they had the co-operation of the profession from the first, as he hoped they would have, there was no doubt of their obtaining complete success in the end. He knew from intercourse with members in the gas industry, that there existed a certain amount of scepticism as to the advantage to be given to the profession by the University; and no doubt there were grounds for this belief. But he would remind them that the University with which the memorial was to be connected was a new one, situated in a great centre of industry, and in an environment which would be sure to bring it into close practical touch with the industries of its neighbourhood and of the country. The only other word he wished to say was that they had found, in connection with all enterprises of this kind in the University, that it was indispensable to have the scientific department advised and controlled by a Committee on which representatives of the separate industries were placed. And he took it—though, of course, all the details of the future scheme were not as yet fixed upon—that the Livesey Professorship would be under the constant supervision of a Joint Committee representing members of the Institution and other branches of the gas profession and also the University academic body. In this way they would have a guarantee that there would be contact between the practical mind and the scientific mind, and that they would have that action and re-action between the intellectual and practical side which was so indispensable for the proper progress of both. Though the vote of thanks had already been passed, he should like to add his tribute to the praise already given to the President for his address, which was full of suggestiveness that would lead to many developments of thought and action which would be of great advantage to the community.

Mr. H. E. Jones said he had just heard that they had raised the £10,000 required, with the exception of about £30. He had been making in a certain quarter an appeal which he hoped would turn out successfully; but, whether it did or not, he would make himself personally responsible for providing the £30.

The President said the members must all feel grateful to Mr. Jones for undertaking this responsibility.

[It may be convenient to record here that, just before the mid-day adjournment, Mr. C. F. Ruggles (Leighton Buzzard) expressed his pleasure in stating that, since the announcement made earlier in the morning with regard to the Livesey Memorial, he had been authorized by the members of the Eastern Counties Association (of which he is the retiring President) to say that they would be very pleased to further augment the fund by twenty guineas.]

On Wednesday morning, after the meeting of the Benevolent Fund,

The President read two letters he had received from Mr. Corbet Woodall and Mr. Thos. Newbigging regretting

their inability to be present at the meeting—the former in consequence of a slight accident, and the latter as he was fulfilling a professional engagement in Toronto. They would, he said, all rejoice to hear that Mr. Newbigging was still energetic enough to cross the Atlantic, and would sympathize with Mr. Woodall, to whom he suggested a message to this effect should be sent.

This was at once agreed to.

Reading of Papers.

The reading of papers was then proceeded with. They were taken in the following order:—

Tuesday.—Report of the Gas Heating Research Committee.

Wednesday.—"Carbonization in Chamber Settings," by Dr. LESSING. "Carbonizing," by Mr. J. FERGUSON BELL. "The Advantages and Disadvantages of a Hot-Coke Conveyor," by Mr. R. WATSON.

Thursday.—"A Comparison between the Illuminating Efficiencies of Carbon Monoxide and Hydrogen when Used in Conjunction with the Incandescent Mantle," by Mr. ARTHUR FORSHAW. "A Study in Working Costs," by Mr. HERBERT LEES. "The Relative Capital Accounts of Gas Undertakings Owned by Companies and Local Authorities," by Mr. ARTHUR VALON.

The papers, with reports of the discussions thereon, will be found in another part of the "JOURNAL."

The Benevolent Fund.

On Wednesday, the annual meeting of the donors and subscribers to this fund was held. A report of the proceedings will be found on p. 885.

The Report of the Carbonization Committee.

The PRESIDENT, after Dr. Lessing's paper had been read, said it was a most important contribution; but before discussing it, he proposed that Mr. J. Ferguson Bell should read his paper on "Carbonization." The report of the Carbonization Committee had also been printed and distributed. This Committee found some difficulty in making a satisfactory report, owing to the pace at which developments were proceeding; but they had been fortunate in securing the services of Dr. Lessing, and his report, which had been prepared under the direction of the Committee, would be found both interesting and instructive. He hoped that, taken in connection with the paper just read, it would be of use to those members who had to plead for the Investigation Fund, and who had perhaps found some difficulty in asking for subscriptions.

Mr. CHARLES HUNT (London) asked if this report represented the whole work carried out by the Committee during the past year.

The PRESIDENT said it could hardly be said to represent the whole of the work, because there was a good deal of work which it was very difficult to put in a report. The Committee had had several meetings to discuss the position and consider how far it was possible to visit various works where new carbonizing plant was erected; and though they decided that they could not visit these new installations on the Continent, they had by no means been idle. On the whole, he thought that the report fairly embodied the views of the Committee.

Condolence with Mr. Forbes Carpenter.

After the discussion of Mr. Forshaw's paper on Thursday morning,

The PRESIDENT said that there were two matters he had to mention. It was within the knowledge of many of them that Mr. Forbes Carpenter, the Chief Inspector under the Alkali Act, had intended to be present and take part in the discussion on the papers on carbonization. In his last report, Mr. Carpenter gave almost a treatise on carbonization developments, which was a most important contribution to their knowledge, and was read with great interest all over the country. Unfortunately, Mr. Carpenter had had a very severe bereavement in the death of his wife, and it was suggested that they should send him a vote of condolence, which perhaps some member would move.

Mr. CHARLES CARPENTER (London) said though his knowledge of Mr. Forbes Carpenter did not extend over so many years as that of many other gentlemen, his acquaintance with him had been one of the most delightful he had ever experienced. In every way Mr. Forbes Carpenter had endeavoured to help the gas man in performing his duties. It was easy to understand that a man of another disposition might make the lot of gas men more difficult than it already was; but Mr. Forbes Carpenter had in every way facilitated their work, and had been helpful to them in every respect. There were some among them who owed Mr. Carpenter a more than ordinary debt of obligation. He proposed that a vote from the meeting should be sent to Mr. Carpenter, expressing deep sympathy with him in the bereavement he had sustained.

Mr. SAMUEL GLOVER (St. Helens) said that, knowing Mr. Carpenter personally and having the greatest respect for him, he concurred most heartily in what Mr. Carpenter had said as to the way in which Mr. Forbes Carpenter assisted with all his weight in his most influential office to the better performance of their duties as chemical manufacturers in relationship to the public. He had the utmost respect for him, and the greatest sympathy for him in his bereavement.

The motion was carried by the members rising silently.

Mr. James Whimster's Absence.

The PRESIDENT said he had just received a letter from Mr. James Whimster, of Armagh, regretting his inability to be present at the meeting through the illness of his wife. They all missed Mr. Whimster's familiar face, especially as he came from Ireland, where they had comparatively few members; and he should take upon himself to write expressing the regret of the members at his unavoidable absence.

The Livesey Memorial Fund.

At the conclusion of the reading and discussion of papers on Thursday,

The PRESIDENT said he was sure they would all be glad to hear that the Livesey Memorial Fund had now reached the grand total of £10,154 7s. 10d. The further list contained contributions of £52 10s. from Mr. Charles Hawksley, £25 from the Lambton Collieries, £21 from the Eastern Counties Gas Managers' Association, £52 10s. from Sir John Aird, £5 5s. from his Manager, Mr. Nisbet, and a number of others from members of the Institution.

Mr. SAMUEL GLOVER remarked that it ought to be thoroughly understood that good use could be made of any sum above £10,000 which might be subscribed.

The PRESIDENT said this was quite true. The sum of £10,000 was named as the minimum; but there was nothing to stand in the way of a further flow of generosity.

The Standardization of Pipe Threads.

The PRESIDENT said Mr. Helps and himself were deputed to attend a conference in Paris last year initiated by the Société Technique du Gaz; and as Mr. Helps had recently been attending a further meeting on the same subject, he would ask him to report what had been done.

Mr. J. W. HELPS said he had prepared a report for insertion in the "Transactions," but did not propose to read it.* He would simply acknowledge the kindness and courtesy shown by the President and Council of the Société Technique, and add that the Institution were greatly indebted to the British Engineering Standards Committee for allowing their representatives to attend the conference, and to Mr. Leslie Robertson and Mr. Krause for the great assistance they rendered thereat.

The New Officers.

The PRESIDENT announced the result of the election of office-bearers for the current year, as follows:—

President.—Mr. J. W. Helps, of Croydon.

Vice-President (in association with Mr. Alexander Wilson, of Glasgow, elected last year).—Mr. R. G. Shadbolt, of Grantham.

New Members of Council.—Mr. J. Ferguson Bell, Mr. John Bond, Mr. Charles Meiklejohn, and Mr. J. W. Morrison.

Auditors.—Mr. James L. Chapman, and Mr. Samuel Wood, F.C.A. (Messrs. Wood, Drew, and Co.).

Hon. Secretary.—Mr. S. Y. Shoubridge.

The PRESIDENT also announced that all the candidates

* The report appears on p. 885 of to-day's issue.

for membership of the Institution had been duly elected. The following is the list :—

MEMBERS.

Angus, J. C., Lighting Engineer, North-Eastern Railway Company, York.
Cleasby, P. C., Engineer and Manager, Guildford Gas-Works.
Cowie, R. W., Engineer and Manager to the Gas Commissioners, Lockerbie.
Davies, D. H., Engineer and Manager, Gas Department, Nantwich Urban District Council.
Frizelle, T., Engineer and Manager, Holyrood (Co. Down) Gas-Works.
Hoggard, A. W., Superintendent, Effingham Street Gas-Works of the Sheffield Gas Company.
Langford, L. J., Engineer and Manager, Abertillery Gas-Works.
Lennon, G., Manager, Dungarvan (Co. Waterford) Gas-Works.
Ramsden, R. S., Assistant-Manager, Burton-on-Trent Gas-Works.
Talbot, H., Engineer and Manager, Todmorden Gas-Works.
Westlake, W. N., Manager and Secretary, Exeter Gas Company.

ASSOCIATE MEMBERS.

Blackman, J. W., Engineer and Manager, Masterton (N.Z.) Gas-Works.
Carpenter, G. W., Engineer's Assistant, South Metropolitan Gas-Works, Rotherhithe.
Clark, H. N., Assistant-Engineer, West Ham Gas Company.
Keable, E. F., Assistant Engineer and Manager, Gorleston and Southtown Gas Company.
King, A. G., Assistant to Mr. W. H. Pearson, jun., Engineer, Consumers' Gas Company, Toronto.
Vince, E. P., Assistant-Manager, Merthyr Tydfil Gas-Works.
Warrilow, J., Assistant-Engineer and Manager, British Gaslight Company, Etruria, Stoke-on-Trent.
Wootten, E. D., Assistant-Manager, Burslem Gas-Works.

ASSOCIATE.

Lessing, Rudolf, Ph.D., F.C.S., Consulting and Analytical Chemist, Southampton House, 317, High Holborn, W.C.

Mr. HELPS, in thanking the members for the honour conferred upon him, assured them that he would do his utmost to see that the prestige of the Institution did not suffer in his hands. Mr. Glover had set him a very difficult task ; but he would do his best to follow him, and to secure if possible as successful a year, and an equally successful meeting, as they had just concluded.

Mr. SHADBOLT also thanked the members for his election, and assured them of his desire to worthily fill the post to which he had been elected.

Next Place of Meeting.

Mr. HELPS said he was one of those who felt that the best chance of having a successful meeting was to hold it in London ; but there were one or two little points in favour of an alternative. They had been drawn into very close connection with Leeds by the establishment of the Livesey Professorship ; and it was the town in which he entered on his own career as a gas engineer, longer ago than he liked to think of. Naturally, therefore, he felt somewhat in favour of the meeting being held there ; but he did not wish to press the point, and placed himself entirely in their hands. Whichever was decided upon, either now or later, he should be equally pleased. He might say that he had received a letter from Professor Smithells, saying that the University Council had passed a resolution cordially approving the suggestion that the Institution should be invited to hold their next annual meeting at Leeds ; and he expected that a formal invitation would follow, in which the Gas Committee of the Corporation would concur.

Mr. H. KENDRICK (Stretford) moved that the question should be left to the decision of the Council.

Mr. D. H. HELPS seconded the motion, which was at once agreed to unanimously.

Mr. EDWARD ALLEN (Liverpool) thought the members should have an opportunity of expressing their wishes, which no doubt would have great weight with the Council. He believed there was an almost unanimous desire that the next meeting should be held in London.

Mr. SAMUEL GLOVER thought what should weigh with them was the meeting-place the following year. It was generally considered that every alternate meeting at any rate should be in London ; and it would be well to bear in mind that, in due course, they might be invited in 1911 to meet in Glasgow. It might be very desirable on some future occasion to go to Leeds ; but, on the whole, he thought next year they should meet in London.

Mr. A. WILSON (Glasgow) having stated that he looked forward to the Institution meeting in Glasgow the following year,

Alderman MILES (Bolton) said if it was in order to pass a resolution for the guidance of the Council, he would move that the next meeting be held in London.

Mr. ALLEN said his proposal was intended to be that in the opinion of the meeting the gathering next year should be in London.

Alderman MILES said he would second this ; and it was agreed to.

The PRESIDENT said he thought the Council would understand what was the general feeling on the matter.

Votes of Thanks.

Mr. HELPS proposed a hearty vote of thanks to the President, not only for the way in which he had conducted the meetings, but also for his services to the Institution during the past year. Mr. Glover had always been at his post, and had extended the greatest courtesy and kindness to everyone with whom he was brought in contact. They owed to him a great debt of gratitude, and also to Mrs. Glover for the interest she had taken in the proceedings. They all enjoyed themselves at the reception ; and he hoped the President would convey their thanks to Mrs. Glover.

The motion being carried by acclamation,

The PRESIDENT said he had done what he could, and only wished he could have done more. The success which had attended his efforts was largely due to the loyal support he had received from the Vice-Presidents, the Hon. Secretary, and every member of the Council, who had all been anxious to forward the interests of the Institution.

Mr. J. P. LEATHER (Burnley) proposed a vote of thanks to the Directors of the British Gaslight Company and the Norwich Corporation for their kind invitation to Norwich.

This also was carried unanimously.

Mr. THOMAS BERRIDGE (Leamington) moved that the best thanks of the Institution be tendered to the Council of the Institution of Mechanical Engineers for their kindness in granting the use of their rooms for the meeting. Had it not been for their kindness, they would perhaps have had to look about for rooms of their own—probably in memory of Sir George Livesey ; but as they had the privilege of using these excellent rooms, they were able to spend the money to better advantage.

The motion was carried unanimously.

Mr. A. F. BROWNE (Vauxhall) moved a vote of thanks to the Scrutineers and to the readers of papers. He said that the President and Council might be heartily congratulated on the excellence of the fare they had had placed before them, which they had greedily consumed ; but it would take enormous powers to digest it. The papers had dealt with matters of exceptional interest, and had been of great individual merit, as was shown by the large attendances.

The motion was carried unanimously.

Mr. J. T. JOLLIFFE (Ipswich) moved a vote of thanks to the Hon. Secretary, Mr. Shoubridge.

This was seconded by Alderman MILES, who expressed the hope that Mr. Shoubridge would try to expedite the preparation and distribution of the "Transactions."

The motion having been carried,

Mr. SHOUBRIDGE said his thanks were rather due to the members for placing him in such enviable position. He would see if anything could be done to meet the point mentioned by Alderman Miles. He then proposed a vote of thanks to their indefatigable and hard-working Secretary, Mr. W. T. Dunn. No public institution, he said, could have a better Secretary.

The vote having been carried unanimously,

Mr. DUNN said it was always a pleasure to him to work for the Institution, and all the more so that his efforts were so kindly appreciated.

Honorary Members.

The PRESIDENT said he had now to do what he ought to have done before—viz., nominate as honorary members of the Institution for the coming year the President of the Société Technique de l'Industrie du Gaz en France, and the President of the German Association of Gas and Water Engineers.

Mr. WILSON seconded the nomination, which was carried unanimously.

This concluded the business.

GAS HEATING RESEARCH.

REPORT OF "GAS HEATING RESEARCH" COMMITTEE

Appointed by the Institution of Gas Engineers in Conjunction with the University of Leeds,

And consisting of Messrs. JOHN BOND, J. H. BREARLEY, and CHARLES WOOD, in co-operation with Professors ARTHUR SMITHELLS (Chairman), WILLIAM A. BONE, and JULIUS B. COHEN, of the University of Leeds, and Mr. E. W. SMITH (Research Chemist).

PREFATORY NOTE.

The object which the Committee have had before them has been to make a scientific investigation of the efficiency of the gas-stove as a heating appliance, and to ascertain the facts in regard to certain hygienic questions that arise in connection with heating by gas. Similar inquiries have frequently been made in the past—some of them of considerable value; but it was hoped that, under the joint auspices of representatives of the coal-gas industry and of the scientific staff of a University, with special resources at their disposal, a more complete investigation might be made, which would carry weight as a statement of facts, and serve as a secure basis for work directed to further improvements upon existing appliances.

The successful prosecution of such an inquiry as the Committee have contemplated, demands a large amount of preliminary work which cannot immediately bear fruit. But the Committee are glad to state that this stage has been passed, and that for some months past they have been able to make steady progress with the actual inquiry. The work was commenced by Dr. Drugman in November, 1907. Under his direction, the experimental room was constructed and was completed in December. The following six months were spent in testing the meters and other apparatus used, and in standardizing materials and methods of analysis and measurement. Thereupon a series of preliminary tests was carried out on "condensing" stoves, chiefly with a view to determining their efficiency in preventing the escape of sulphur products.

At the end of October, 1908, Dr. Drugman resigned his position as chemist in charge, and was succeeded by Mr. E. W. Smith, M.Sc. The Committee desire to acknowledge the valuable work done by Dr. Drugman, who applied himself with unremitting industry and scrupulous care to the somewhat tedious labour of the preparatory work. Since Dr. Drugman's departure, Mr. Smith has carried on the experiments to the great satisfaction of the Committee, and has proved himself to be highly qualified for the work. The results obtained by Mr. Smith, which are recorded in the present report, were obtained between the middle of November, 1908, and the end of March, 1909.

The Committee hope that these results may be considered as sufficiently important to warrant a continuation of the inquiry, so that it may embrace many other questions that demand accurate investigation—such, for example, as the efficiency of different kinds and arrangements of radiating material and burners, and methods for securing ventila ion.

(Signed) ARTHUR SMITHELLS, *Chairman.*
WILLIAM A. BONE.
JULIUS B. COHEN.
JOHN BOND.
J. H. BREARLEY.
CHARLES WOOD.

INTRODUCTION.

When coal gas is burned in an enclosed space, the amount of heat* communicated to that space depends only on the chemical composition of the gas and the amount of it that is burned, provided that in the end it is burned completely to carbon dioxide and water. No mechanical contrivance can increase the total output of heat.

If we suppose the gas to be burned in a naked flame, the heat is delivered to the surrounding space in three ways. In the first place, the hot products of combustion stream upwards, intermingling with the air, warming it and any surfaces with which they come in contact. In the second place, a certain amount of air is warmed by contact with the flame; and this also carries away heat. Heat distributed by hot currents of gases is said to be convected. In the third place, the flame parts with some of its heat by emitting rays through the air in every direction on to the objects in the room. Heat distributed in this way is said to be radiated.

If the utility of an appliance for heating by gas depended solely on the amount of heat that was given out, a simple burner giving a naked flame, whether luminous or atmospheric, would be as effective as any other appliance. But the utility of a gas-heating appliance such as a gas-stove must be considered in regard to a number of practical questions:

1.—If, for example, we desire not to introduce the products of combustion into the space we are heating, we must provide the stove with a flue sufficiently large to carry off these products. The flue may be so arranged, as to its length and the conductivity of its material, that it will drain off most of the heat of the gases passing through; so that if the flue, before opening into the outside air, is wound about inside the space that is being heated, the products of combustion may be got rid of without taking much heat with them.

2.—Again, we may desire to avoid very hot currents of air, which rise at once to the ceiling. And in that case, instead of using a naked flame, we should cause it and its products to heat up metallic surfaces of some considerable extent. These heated surfaces would then cause much cooler and broader and more slowly moving upward currents of air, which would set up a more general circulation in the room.

3.—We might desire to obtain as much heat as possible in the form of radiant energy sensible as heat. In that case we should cause the flame and its products to heat up some material of such a kind and in such a way that it drained a very large quantity of heat from the flame and emitted it again in the form of radiation.

4.—Lastly, it may be supposed that a gas-stove is desired not only to heat, but to ventilate, a room. In that case it will have to be so used as to eject air in addition to its own products of combustion.

Other considerations might be named; but these are sufficient to emphasize the chief points that have to be considered in regard to the heating efficiency of gas-stoves. And gas-stoves might be relegated to one or other of three categories according as they heated a room mainly: (1) By direct diffusion of hot products of combustion; (2) by heating surfaces which caused convection currents of warm air; (3) by radiation. Stoves of the first type are to be found in the "reflecting stoves," which are not infrequently used to take the chill off the air of shops. Stoves of the second type include "radiators," "steam radiators," and "condensing" stoves. [The use, or rather the misuse, of the word "radiator" in this connection is based on a similar misuse which has become common in connection with steam or hot-water heating coils. These appliances would be more correctly called "convectors," as their heat is almost entirely delivered by warming the surrounding air, and so causing convection currents.] Stoves of the third type include the normal gas-stove, where atmospheric flames are caused to heat up a refractory fuel to the highest possible temperature. Of course, there are stoves of intermediate type, in which more than one of these methods plays an important part.

There can be no doubt that the form of heating most acceptable to the Englishman in a living room is radiation from a bright fire; and it is in the comparison of the brightness and radiant warmth of coal-fires and gas-fires that gas-fires (apart from questions of cost) are commonly disparaged. There is also a very widespread and deeply-rooted belief that a gas-fire, even if satisfactory as a radiator, is necessarily attended by some hygienic disadvantage.

In taking up the study of gas-heating appliances and endeavouring to gain an accurate estimate of their efficiency, the Committee felt that they might best begin with a study of the radiating efficiency of gas-stoves—including, incidentally, a study of the hygienic conditions. If the radiating efficiency of gas-stoves can be materially improved, and if it can be shown that a gas-stove, when properly constructed and used, has no more deleterious influence than a coal-fire, a great advance will have been made towards the substitu-

* To ensure clearness the word "heat" is used here, although it would be more scientifically accurate to substitute "energy."

tion of gaseous for solid fuel as a means of domestic heating. In the following report will be found details of the measurements of radiation from one of the prevailing types of gas-stove with fire-clay fuel. These measurements, it is believed, have been made with as much accuracy as is at present possible, and give for the first time a tolerably correct absolute measurement of the radiating power of a gas-stove.

OPEN GAS-FIRES.

By E. W. SMITH.

This included the determination of :

(*a*) The total energy radiated as heat from the stove.

(*b*) The effect on the radiation of changes in the volume of air passing through the room and up the flue.

(*c*) The extent of the so-called "drying" of the room air where open gas-fires are used.

(*d*) The extent of the vitiation of the room air caused by open gas-fires.

(*e*) The amount of heat passing directly up the flue and not available for heating the room.

(*f*) The amount of carbon dioxide found (1) in the room and (2) in the flue.

(*g*) The amount of heat used in heating the air of the room.

(*h*) The volume of air that might be raised from 45° to 60° Fahr. by the heat available in the stove.

(*i*) The effect of using a reflector.

(*j*) The effect on the heat lost to the room, of changes in the volume of air passing up the flue.

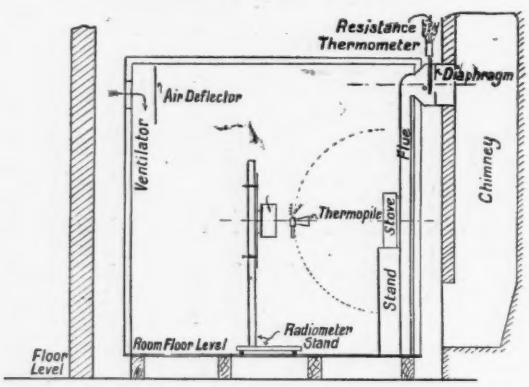


Fig. 1.—Section on Line A B (Fig. 2) of Experimenting Room.

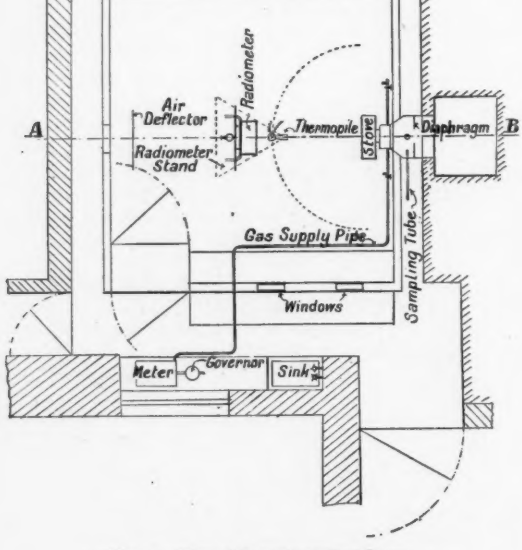


Fig. 2.—Plan of Experimenting Room.

Description of the Experimenting Room.—It was very necessary in connection with this work that the varying conditions to be coped with should be completely under control. For this purpose, a special chamber was built (see figs. 1 and 2) in one of the rooms of Woodhouse Lodge—a building which is adjacent to the Fuel Department of the University of Leeds. It consisted of a double-walled room built of tongued and grooved boards, the inner and outer walls being about 2½ inches apart. These were made as nearly as possible air-tight by lining the inside walls with calico, coated with asbestos paint, and the outside walls with a thin coating of pitch. The floor, which had to bear the weight of the stoves, &c., consisted of a layer of tongued and grooved boards made air-tight with painted calico. Over these asbestos board was laid, and on the top of this a sheet of asbestos-magnesia cement.

The room was as large as the available space allowed—viz., 9 ft. by 9 ft. by 9 ft., with an internal capacity, after allowing for the various articles in the room, of 710 cubic feet. Only one side was easily accessible, and in this side double doors, connected with an air-tight passage, gave access to the interior without danger of cold air suddenly entering. The rest of this side was fitted with shelves, both inside and outside, on which apparatus could be placed. There were two windows (14½ inches by 10 inches) immediately above the shelves, so that the apparatus could be watched from outside.

Air was admitted through movable panels, 10 inches square, at the top and back of the room; and the products of combustion were carried away through a square flue placed at the opposite side of the room, near the ceiling. This flue was connected with the chimney of the outer room—an ordinary kitchen chimney. As it was important that this flue should be quite air-tight, the inner lining was made of galvanized sheet iron. So that the combustion products might be drawn away if required, at a uniform rate, a small electric fan was used, and fitted exactly into the outer end of the flue. This could be run at either a high or low speed. This, as well as the electric lights within the room, was controlled by switches from outside.

The gas-supply pipe passed into the room through a panel, and was directly connected to the test-meter, standing on a shelf outside the room. This, in its turn, was connected through a Stott's governor with the house supply meter. The general plan and section of the room can be seen from figs. 1 and 2.

The flue inside the room was made of sheet copper, wrapped with asbestos board in order that there should be as little loss of heat as possible from the flue gases before they passed into the kitchen flue, outside the experimenting room. The flue left the room by means of a hole 8½ inches square, 8 ft. 4 in. from the ground. Its cross section dimensions were 6 inches by 4 inches; and at the point where it left the room its cross-sectional area might be reduced either to 4 inches by 4 inches or to 3 inches by 3 inches. At this point, too, an electrical resistance thermometer was brought into use—this being connected with a Callendar recorder, erected in the main buildings. Arrangements were made that samples of gases might be drawn from the room from immediately above the stove, and from the flue near to the thermometer. This was done by means of aspirators, in which the volume of gas abstracted could be measured.

Method of Estimating the Rate of Air Change in the Room.—The chemical method was adopted for the estimation of the rate of air change in the room as being likely to prove the most accurate for the work in hand. The mode of procedure was as follows:—

1.—A determination was made of the carbon dioxide contents of the outside air in parts per 10,000 (Pettenkofer method, modified).

2.—A sample was taken, extending over the whole time occupied in doing the ventilation experiments (15 to 20 hours), of the gases passing up the flue, and the carbon dioxide contents determined in parts per 10,000.

3.—The gas-rate, in cubic feet per hour, was accurately determined and reduced to 0° C. and 760 m.m. pressure, dry.

4.—A sample of the gas burnt was abstracted from the main before entering the test meter, during the whole experiment. This was exploded with oxygen in a "Bone and Wheeler" gas analysis apparatus, and the amount of carbon dioxide formed from the combustion of a cubic foot of the consumed coal gas estimated.

From (4) and (3) was estimated the volume of carbon dioxide (at 0° C. and 760 m.m. dry) passing into the flue per hour. Then if (1) = x; (2) = y; (4) = z; and if the

volume of air passing up the flue per hour equals "v," then

$$v = \frac{z}{y - x} \times 10{,}000.$$

Carbon Dioxide Determinations.—Pettenkofer's method was employed with the modifications proposed by Letts and Blake.* These consisted (1) in coating the inside of the sampling vessels with paraffin wax, to prevent the glass being attacked by baryta solution; and (2) carrying out the titration in a vacuum. A further modification consisted in having a soda-lime tube fitted to one of the holes in the corks of the sampling bottles, and also a three-way glass tap. The same was done with the titration flask. By this means, atmospheric carbon dioxide was prevented from entering these vessels should the gases contained contract owing to a fall of temperature in taking them into the laboratory, which remained fairly constant between 56° and 60° Fahr. The results obtained by this method were checked by a gravimetric determination, by drawing a sample over calcium chloride, sulphuric acid, caustic potash, and soda lime. They were not found to differ seriously. The samples of flue gases were always analyzed gravimetrically.

Carbon Monoxide Determination.—The flue gases were also analyzed for carbon monoxide in most experiments, as were also the gases abstracted from immediately over the stove. The method depending on the liberation of iodine from iodine pentoxide by means of carbon monoxide, and the formation of carbon dioxide, was adopted.

$$5\,CO + I_2O_5 = I_2 + 5\,CO_2.$$

The amount of change was estimated colorimetrically by absorbing the iodine in chloroform and comparing the solution with equal volumes of standard solution. This method was open to slight error, as the iodine pentoxide was liable to be reduced by other constituents in the sample than carbon monoxide—as, for example, by formaldehyde, the presence of which in the products of combustion was most probable. The quantities of carbon monoxide found in all cases were so small that, assuming the whole of the change was caused by this gas, the figures are sufficiently convincing to show that during the course of these experiments only negligible quantities were formed, if any at all.

Hygrometric Measurements.—Wet and dry bulb thermometers, previously tested, were placed inside and outside the room, so that the percentage saturation of the inner and outer air might be determined. Glaisher's tables were used. Both hygrometers could be read from outside the room.

Sulphur Determinations.—The Gas Referees apparatus was open to two likely sources of error—firstly, in the incomplete oxidation of the sulphur, and, secondly, by contact of the hot parts with rubber containing sulphur. An apparatus was designed in which all the connections were ground glass joints, and in which the combustion products were led over hydrogen peroxide solution, and cooled by passing through a water-cooled condenser tube. The results were higher than those got by the Gas Referees apparatus.

Temperature Measurements.—All thermometers were on the Centigrade scale, and were constantly checked for accuracy. The flue temperatures were taken continuously by means of an electrical resistance thermometer, and registered on a Callendar recorder placed on the wall in the main building. With proper attention, it worked satisfactorily. The temperatures of the air in the experimenting room were determined by placing thermometers on all the walls in different positions, and hanging from the ceiling in the middle of the room—the bulbs of all being protected from direct radiation from the stove by placing each in the shadow of a piece of asbestos. The temperature of all gases passing through the various meters was taken by fixing thermometers into the meters above their water-levels.

Calorific Values.—These were determined by means of a Boys' calorimeter, the water being weighed instead of measured, and the net values determined by weighing the water condensed over half-an-hour, and checking this by calculating the amount of water produced during combustion from an analysis of the gas. The latter figure was always a little higher than the former; the escaping products of combustion having a slightly higher percentage saturation than the atmosphere.

Coal-Gas Analyses.—These were all done on the "Bone and Wheeler" apparatus, in which all measurements were made at constant volume. Complete analyses for CO_2, O_2, unsaturated hydrocarbons, CO, CH_4, H_2, and N_2 were accurately made in about eighty minutes. Nitrogen was taken by difference. A typical analysis is as follows:—

CO_2	·14 per cent.
O_2	·41 ,,
Unsaturated hydrocarbons	3·9 ,,
CO	6·3 ,,
H_2	39·04 ,,
CH_4	33·9 ,,
N_2	16·27 ,,

Gas-Rates.—These were estimated by noting the time taken by a cubic foot of gas to pass through the meter; correction being made by reducing the volume to 0° C. and 760 m.m. pressure, dry. The pressure of the gas at the meter was allowed for.

The Meteorological Conditions.—These were obtained from the "Cecil Duncombe" observatory, close to the laboratory. The barometric pressures which were required for each volumetric calculation were got from a barometer in the analytical laboratory.

Experiments with the Open Gas-Fire.

The stove used in the tests was of the simplest type and of normal size (see fig. 3).

Fig. 3.

It consisted of seven bunsen burners all connected with the same air and gas supplies, which were adjustable (see fig. 4, A and B). Combustion took place within seven pieces of open fire-clay fuel; and the tips of the flames and hot products passed through similar material arranged across the top of the tube-like fuel. The stove had a thick fire-brick back; and the gaseous products passed out by means of a hole ($4\frac{1}{4}$ in. by $1\frac{1}{8}$ in.) into the copper flue already described.

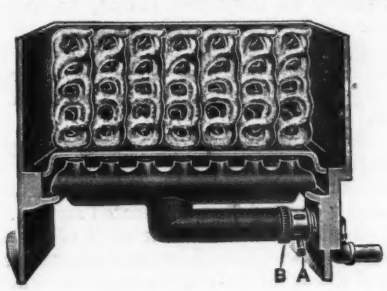


Fig. 4.

The whole was surrounded by a cast-iron frame-work. The fire-clay front measured 9 inches by 9 inches.

The air supply to the burners was so arranged that, after getting a distinct inner cone, it was adjusted until a slightly hazy inner cone was obtained. The flame was of such a size and shape that the outer cone, where combustion was being completed, very slightly impinged on the fire-clay fuel. The space beneath the fuel and round the burners was filled in so that the heat of the fire caused as little

* "Proceedings of the Royal Society, Dublin, 1900," p. 107.

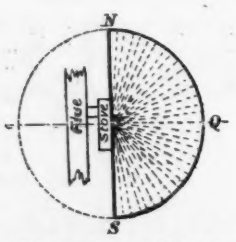


Fig. 5.—Side Elevation of Radiating Stove.

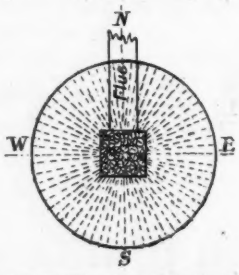


Fig. 6.—Front Elevation of Radiating Stove.

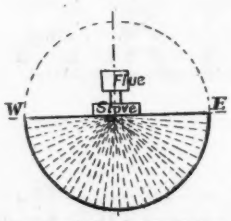


Fig. 7.—Sectional Plan of Radiating Stove.

draught as possible through the fire, with consequent loss of heat. The average gas consumption was 17 cubic feet per hour, and the net calorific value was about 142 calories (571·4 B.Th.U's.).

Estimation of Radiant Energy Sensible as Heat.

The chief work done since November has been the devising a method of estimating quantitatively the percentage of energy radiated as heat from the usual type of open gas-fire (fig. 3). The two main points that presented themselves were: First, to decide on the most suitable, and at the same time a sufficiently accurate means of estimating the rate of reception of radiant energy at any given point; and, second, to so apply this means as to be able to determine quantitatively the total energy radiated from the whole area of the heated surface. Sir John Leslie, a pioneer in research on radiation, used a differential thermometer, consisting of a U tube with a bulb at either end; one bulb only being exposed to radiation. This instrument is not sensitive enough, and, owing to the conditions of the work, would not be at all suitable.

Langley used an instrument which he called the bolometer.* This is very sensitive, portable, and receives radiation in every direction. Its principle is that of an electrical resistance thermometer, and is extremely simple to use. The radio-micrometer invented by D'Arsonval, and subsequently improved by Boys,† is also extremely sensitive, but not so handy as the bolometer. Its principle is that of the single thermo-junction and mirror galvanometer in one instrument.

The thermopile was the instrument eventually adopted, and, with proper precautions, has proved eminently reliable. It was of the Rubens type, and consisted of twenty junctions of iron and constantan wires in series, every alternate junction being shaded, and at the room temperature, and the remaining junctions exposed to the radiation. An electric current is set up flowing from one to the other, proportional to the difference in temperature of the hot and cold junctions. This current was shown on a Paul single-pivot galvanometer in milli-volts. There was also a temperature scale on the galvanometer, which could be brought into use by putting 10 ohms into the circuit by means of a convenient switch. The temperature scale having a much smaller range of deflection, the milli-volt scale was always used. As the temperature of the room affected all the thermo-junctions to the same extent, no increased difference in deflection of the galvanometer was shown by variations in the room temperature. Nevertheless, the galvanometer was always brought to zero after each reading, and any slight differences in its internal resistance allowed for.

When a satisfactory method for registering the comparative radiation intensities at various points was found, additional means had to be adopted for estimating the total radiated energy emitted from the heated surface. It would have been possible to absorb all or most of the radiations; but the method would have been so long and tedious that at the end of the experiment there was every likelihood that most of the conditions of the experiment would have changed. The method adopted was as follows: It was known that energy would be radiated to every point from which the fire was visible. This distribution is shown diagrammatically in figs. 5, 6, and 7, where the radiation is represented as falling on the inner surface of the hemisphere N.Q.S. (fig. 5). If, then, the radiated energy falling on the surface of the hemisphere could be estimated, the problem was solved. A promising instrument for making this measurement was found in a so-called radiometer designed by Professor R. H. Smith; and with this the experiments were made (fig. 8). This instrument consisted of a surface 12-inches square, composed of flattened copper tubes, connected in series, through which a current of water was caused to flow.

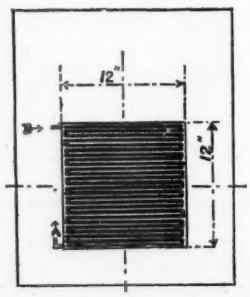


Fig. 8.—Front View of the Radiator.

The tubes were close together, and lampblacked, besides being protected by a lampblacked sheet-iron hood to protect the surface of the tubes from warm convection currents. Water was run through the tubes from a constant level and left the apparatus at a constant level, thus ensuring an even flow. Thermometers were so placed that the temperature of the water could be taken on entering and leaving the tubes. In using the instrument, it was placed facing the source of radiation, so that the radiant energy falling on the 12-inch square surface of tubes might be absorbed, and the water passed through the instrument would be raised in temperature.

By taking the temperature of the water as it entered and left the radiometer, the average rise in temperature was obtained. From the average rise in temperature and the weight of water flowing through in a given time, the heat equivalent in calories of the radiations falling on the radiometer surface per hour was calculated. The size of the hemisphere upon which the radiations fell had to be determined. It depended on the size of the radiometer. This was 12 inches square. The circumference of the hemisphere should be exactly divisible by 12; and the radiometer in one position should be directly opposite the stove. It was decided that the semicircle forming the circumference of the hemisphere should be 108 inches in length, this being

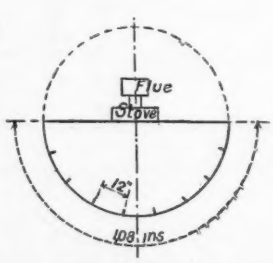


Fig. 9.—The Divided "Equator."

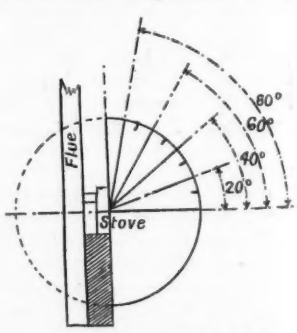


Fig. 10.—Diagram of the Cosine Correction.

divisible by the width of the radiometer, 12 inches. There would then be four divisions on the equatorial rod on either side of the centre division, or nine in all (see fig. 9). If the half circle measured 108 inches, then, by calculation, the radius or distance from the centre of the stove to the radiometer surface, or to the equator, would be 34·4 inches.

* "Nature," Vol. XXV., 1881, p. 14.
† "Philosophical Transactions" 1889 A., p. 158.

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TABLE I.

Experiment.	Remarks.	Fan Rate and Size of Stop in Flue.	Gas Rate, Cubic Feet at 0° C., and 760 m.m. dry.	Calorific Value Net in Calories.	Total Calories per Hour.	Percentage of Heat Lost to the Room, and Passing up the Flue.	Percentage of Energy Radiated Above the Floor Level.	Percentage of Energy Radiated.	Percentage of Heat Used in Heating the *Air* of the Room.	Volume of Air that Might be Heated from 45° F. to 60° F. from 1.	Cubic Feet of Air Passing Up the Flue per Hour at 0° C. and 760 m.m.	Temperature *Outside* the Room, °C.	Temperature *Inside* the Room, °C.	Temperature of the Flue Gases, °C.	Rise in Temperature in the Room, °C.	Rise in Temperature in the Flue, °C.	Carbon Dioxide. Parts per 10,000.		Carbon Monoxide. Parts per Million.		Barometer in m.m. of Mercury.	Percentage Humidity.		Water Vapour Present per Cubic Feet of Air.		Gas Pressure in Inches of Water.
																	Outside the Room.	Inside the Room.	Inside the Room.	In the Flue.		Outside the Room.	Inside the Room.	Outside Grains.	Inside Grains.	
1	Preliminary experiment. Stove on the floor.	Fan half on. Stop 9 sq. ins.	17·08	164·9	2816	31·18	24·73	—	8·5	3332	1718	12·1	28·2	87·0	16·1	58·8	5·4	6·2	—	—	—	69	43	3	5	15
2		,,	17·73	132·6	2352	29·47	25·5	—	8·02	2615	1308	8·4	25·0	86·0	16·6	61·0	4·0	4·4	—	—	768	73	46	2·7	4·5	15
3	Stove on the floor.	,,	17·28	143·9	2486	30·33	27·7	—	7·46	2570	1404	8·0	23·2	85·0	15·2	61·8	4·33	4·20	—	—	765	72	46	2·5	4·5	15
4		,,	17·11	150·0	2566	—	—	—	—	—	1318	9·2	25·2	87·0	15·8	60·0	3·3	3·9	—	—	751	86	47	3·3	4·6	14
5		,,	16·87	144·6	2440	31·54	—	—	8·62	2915	1432	8·3	25·2	87·0	16·9	61·8	3·28	3·3	—	—	729	73	44	2·7	4·3	16
6	Stove raised 40 inches from the floor.	,,	17·56	150·3	2638	29·66	—	29·8	8·15	2982	1500	9·5	26·0	86·0	16·5	60·0	6·65	6·85	—	—	747·8	83	49	3·3	4·8	15
7		,,	17·95	148·8	2672	31·84	20·94	29·27	—	2896	1483	10·6	26·8	87·0	16·2	60·2	4·0	4·9	—	—	763·5	86	47	3·6	5·2	14
8	The centre of the foot of the stove was horizontally opposite the centre of the radiometer and the "equator."	,,	16·92	146·6	2482	29·52	24·53	35·24	7·32	2519	1349	8·0	23·5	86·0	15·5	62·5	3·6	3·5	—	—	738·2	81	48	2·6	4·2	16
9		,,	17·74	148·9	2642	—	21·14	29·66	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	16
10		,,	17·12	142·9	2446	—	22·87	33·02	—	—	—	—	—	—	—	—	—	—	—	—	754·6	79	48	3·1	4·4	16
11		,,	17·60	143·16	2527	—	25·3	31·1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
12	Stove 40 ins. from the floor.	,,	17·60	143·16	2527	—	19·5	29·3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
13	The centre of the stove is horizontally opposite the centre of the radiometer and the equator.	Fan full on. Stop 9 sq. ins.	17·62	137·7	2432	45·13	28·4	35·3	11·48	3871	2100	9·7	25·0	85·0	15·3	60·0	3·55	3·62	—	—	754·5	82	47	3·4	4·3	14
14		,,	17·90	147·5	2640	37·8	25·4	31·0	9·16	3351	1760	7·9	23·7	89·0	15·8	65·3	3·54	3·70	none	none	743	78	47	2·7	4·1	16
15		Fan off. Stop 9 sq. ins.	17·25	153·7	2701	15·52	—	—	3·07	1152	483	10·3	30·1	130·0	19·8	99·9	4·4	6·2	trace	3·0	762·8	79	33	2·7	4·8	16
16		,,	18·10	142·47	2578	21·42	21·96	27·37	3·55	1268	494	8·5	29·8	132·0	21·3	102·2	3·2	6·0	none	none	769	69	39	2·6	5·1	16
17		Fan off. Stop 16 sq. ins.	17·34	141·7	2457	18·77	24·87	30·6	4·08	1389	538·6	8·1	29·5	128·0	21·4	98·5	3·3	5·7	none	·7	769	67	35	2·5	4·7	16
18		,,	17·48	146·24	2557	20·05	—	—	4·03	1430	593·6	5·6	25·6	125·0	20·0	99·4	3·74	6·0	none	·3	745·8	75	45	2·3	4·5	18
19		,,	17·23	140·1	2414	—	27·6	34·3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	18
20	Without reflector . . .	,,	17·69	141·86	2509	—	25·4	31·38	—	—	} 10·17 per cent. more energy is radiated above the floor with a reflector than without.															16
21	With reflector	,,	17·69	141·86	2509	—	28·6	31·38	—	—																16
22	Large condensing stove . .	—	13·05	142·9	1865	—	20·07	25·0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	18
23	Small condensing stove . .	—	11·19	141·1	1579	—	17·84	22·37	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	18
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z

When the points immediately above and below the stove (which to carry the analogy with the earth a little further, may be considered as the North and South poles) were joined by ten meridians passing through each of the points marked off on the iron rod or equator, it was found that these lines converged at the North and South poles at an angle of 20° to one another. Parallels of latitude were then drawn 12 inches apart, starting from the poles. The surface of the hemisphere was then divided somewhat as follows, with each parallel 20° above or below its neighbour (see fig. 11): In the centre there is a 12 inch square, and there are both to the right and left of this square four equal squares in the same plane, making nine in all. Now the division N, A, C, S, D, B is exactly the same shape and area as each of the divisions to its right and left, and the parts of these divisions between the same parallels are equal; so that, for example, E, F, G, H, K, L, M, N, P, are equal to one another. But the areas between the same adjoining meridians decrease as they leave the equator. It is found that *these areas decrease the further they are from the equator in proportion to the cosine of the angle that the line joining the centre of the area to the centre of the stove makes with the line joining the centre of the stove and the equator* (see fig. 10).

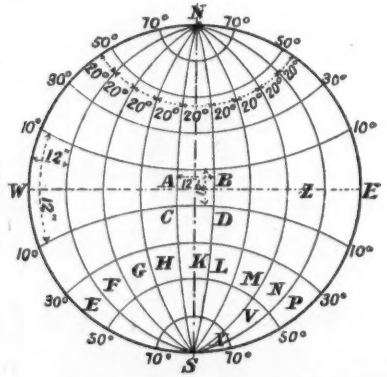


Fig. 11.—The Hemisphere Surface, in Front of the Stove, Divided into 81 Areas.

So that the areas between
10° S and 10° N of the equator will be to the areas between 10° S and 30° S or 10° N and 30° N as 1 is to cosine of 20° = 0·94.

Also the areas between
10° S and 10° N will be to those between 30° S and 50° S or 30° N and 50° N as 1 is to cosine 40° = 0·766.

Also the areas between
10° S and 10° N will be to those between 50° S and 70° S or 50° N and 70° N as 1 is to cosine 60° = 0·5.

Also areas between
10° S and 10° N will be to those between 70° S and 90° S or 70° N and 90° N as 1 is to cosine 80° = 0·174.

There are now 81 areas, each nine of which bears a relation to the remaining areas as 1 : 0·94 : 0·766 : 0·5 : 0·174

TABLE II.

Number of Experiment.	Conditions Under Which the Experiment was Run. Fan: A = Half Speed, B = Full, C = Fan off Stop = 9 or 16 Square Inches.	Meteorological Conditions. Wind: Direction and Rate. Sky: Fraction Under Cloud.	Barometer in Millimetres of Mercury.	Hygrometer Inside Room. Wet °F.	Hygrometer Inside Room. Dry °F.	Hygrometer Outside Room. Wet °F.	Hygrometer Outside Room. Dry °F.	Dewpoint. °F. In.	Dewpoint. °F. Out.	Percentage Saturation or Degrees of Humidity In.	Percentage Saturation or Degrees of Humidity Out.	Vapour in a Cubic Foot of Air in Grains. In.	Vapour in a Cubic Foot of Air in Grains. Out.
1	Stove on floor, A 9	S.W. $\frac{7}{10}$; blue, Cirrus, squally, rain	..	67·64	82·7	47·9	52·2	57·6	41·9	43	69	5	3
2	,, ,, ,,	W. Dead calm, very wet fog	768	63·0	76·1	43·4	47·6	53·7	38·7	46	73	4·5	2·7
3	,, ,, ,,	N.W. Dead calm, very foggy	765	63·1	76·8	42·5	45·9	53·5	36·5	46	72	4·5	2·5
4	,, ,, with reflector, A 9	S.W. $\frac{7}{8}$; blue, variable sky	751	64·0	77·0	46·0	48·6	54·9	43·3	47	86	4·6	3·3
5	,, ,, ,, ,,	W.N.W. $\frac{4}{10}$; blue, Cirrus, bright	729	63·9	77·3	43·2	47·0	53·1	38·9	44	73	4·3	2·7
6	Stove, ft. ins. from floor, A 9	S.E. Very foggy	747·8	64·0	76·8	46·4	49·1	55	43·5	49	83	4·8	3·3
7	,, ,, ,, ,,	N.E. Foggy, dull	763·5	67·0	80·3	49·5	51·8	57·9	46·3	47	86	5·2	3·6
8	,, ,, ,, ,,	W.S.W. 10-30 miles per hour. $\frac{3}{10}$; blue, snow	738·2	61·2	73·4	40·5	43·2	52·3	37·3	48	81	4·2	2·6
10	,, ,, ,, ,,	W. 0-37. $\frac{10}{10}$; overcast, Nimbus, variable, squalls	754·6	62·0	74·1	46·2	49·6	53·2	42·7	48	79	4·4	3·1
13	,, ,, ,, B 9.	W. Calm. $\frac{10}{10}$; overcast, rain, sleet	743	60·5	73·4	42·6	45·9	51·0	38·9	47	78	4·1	2·7
14	,, ,, ,, C 9.	E. Calm. $\frac{10}{10}$; fog, hoar frost, bright later	762·8	68·7	89·0	43·4	48·02	56·1	38·3	33	70	4·8	2·7
15	,, ,, ,, ,,	E. Calm. $\frac{10}{10}$; overcast, bright later	769	68·9	85·8	42·8	48·0	57·8	37·1	39	67	5·1	2·6
16	,, ,, ,, C 16	N.N.W. 2-19. $\frac{10}{10}$; overcast, snow	769	67·7	86·36	41·9	47·0	55·6	36·2	35	67	4·7	2·5
17	,, ,, ,, ,,	W.N.W. Calm. $\frac{0}{10}$; bright	745·8	63·5	77·4	38·3	41·9	53·8	34	46	75	4·5	2·3

corresponding to the cosine of the angles of 0° : 20° : 40° : 60° : 80°.

If this be set out in the form of a table, it is as follows:—

TABLE III.

—	West. 80°	60°	40°	20°	0	East. 20°	40°	60°	80°	Relation of Areas. E.	—
80										0·174	
60										0·5	
40										0·766	
20										0·94	° North.
0										1·00	← Equator.
20										0·91	° South.
40										0·766	
60										0·5	
80										0·174	

Thermopile readings were taken at the centre of each of the areas. Then the amount of radiant energy falling on the areas was proportional to the thermopile readings, whether in milli-volts or degrees Centigrade, and to the size of the areas. The thermopile readings having been taken, all that was necessary was to multiply each reading by its proportionate factor, as in column E (Table III.), and the correct relative values of the radiant energy falling on all the areas constituting the hemisphere was determined. Now, by means of Smith's radiometer, the real calorific values of the radiant energy falling on the centre area on the equator were determined, and knowing this, the remaining values were calculated and totalled, giving the total radiated energy received on the surface of the hemisphere.

The device used for moving the thermopile accurately to the centre of each division consists of two semicircular iron rods. One, the equator, is fixed; the other is fastened at each end by hinges to the north and south poles, and its centre point describes a semicircle about the other—being able to move east and west of the "Greenwich" meridian. The thermopile is fixed on this vertical rod at various points, 20°, 40°, 60°, and 80° above and below the horizontal rod, readings being taken to the right and to the left of the centre readings.

Table IV. is a typical example of a radiation experiment in which the whole of the thermopile readings have been filled in. The figures in column "A" show the height in degrees above and below the equator of the readings in the same horizontal lines. The figures in the same horizontal line with "A" are the thermopile readings east and west and north and south of the centre meridian and the equator respectively. Column K contains the totals of the thermopile readings lying between the same parallels. Column L contains the corrections for decrease in area of the divisions, and column M contains the corrected totals. If these totals are added together and the sum divided by the centre reading, at which point a radiometer determination had been made in calories, then a figure is obtained which shows the number of times that the calorific value of the (12-inch)² centre reading is found over the whole hemisphere.

The energy radiated on to the centre square, as determined by the radiometer = 27·35 calories.

Then the total energy radiated as heat = 27·35 × 25·8 = 705·7 calories.

TABLE IV.—*Thermopile Readings.*

A	To Left. 80°	60°	40°	20°	0°	To Right. 20°	40°	60°	80°	Total of Uncorrected Readings. K.	Cosine Correction. L.	Corrected Totals. M.
80°	0·4	0·5	0·6	0·8	1·0	0·9	0·8	0·6	0·5	6·1	0·174	1·06
60°	0·6	1·5	2·6	3·2	3·4	3·3	2·8	1·7	0·7	19·8	0·5	9·9
40°	0·8	2·4	4·6	5·4	5·7	5·6	4·8	2·6	0·9	32·8	0·766	25·12
20°	1·3	3·6	5·8	6·9	7·2	6·9	5·8	3·6	1·3	42·4	0·94	39·85
0°	1·3	4·2	6·6	7·2	8·0	7·2	6·6	4·2	1·3	46·6	1·0	46·6
20°	1·3	3·9	6·6	7·3	7·6	7·3	6·6	3·9	1·3	45·8	0·94	43·05
40°	1·2	3·1	5·0	6·0	6·2	6·0	5·0	3·1	1·2	36·8	0·766	28·18
60°	0·8	1·9	3·0	3·5	3·6	3·5	3·0	1·9	0·8	22·0	0·5	11·0
80°	0·6	0·8	1·2	1·6	1·6	1·6	1·2	0·8	0·6	10·0	0·174	1·74
											Total	206·5

Total readings = 206·5
Centre reading = 8·0

∴ Factor for radiometer value = $\frac{206·5}{8·0}$ = 25·8

If the gas-rate is known, and also the net calorific value of the gas, the percentage energy radiated as heat of the total heat of the fire may be determined.

Gas-rate = 18·1 cubic feet per hour.

Net calorific value of the gas = 142·47 calories.

∴ The total calories produced per hour
= 18·1 × 142·47 = 2578.

∴ Percentage of energy radiated as heat
= $\frac{705·7}{2578}$ = 27·37 per cent.

Radiation Determinations.

The first few experiments were preliminary, and were done for the purpose of finding the best conditions under which the determinations should be made, and the precautions that must be taken that reliable results may be obtained. Considerable difficulty was caused by the fact that the coal gas from the town's supply would vary in its calorific value by 3 per cent. during the course of an experiment. Should a change take place during a radiometer determination, this might cause a serious error. If the calorific value rose, then the figures for the percentage energy radiated would be high. This is the probable explanation that is offered for the slight discrepancies that occur between figures obtained from experiments performed under otherwise similar conditions.

The first three experiments had for their object the determination of the percentage energy radiated above the floor level, no account being taken of that radiated to the floor. These had an average of 26 per cent. (Column G, Table I.). Subsequently, it was thought that greater accuracy would be obtained if the stove were raised some distance from the floor, in order that the heated floor should not affect the radiometer. This, and another change which will be indicated later, made a difference in the energy radiated of about 4 per cent., which would bring the above figure (26) down to about 22. This agrees with the mean of later determinations (Experiments 6 to 11). The fan in the flue, used in the earlier experiments (Nos. 1 to 14) for the purpose of maintaining a constant draught, was at half speed. The exit from the flue was 9 square inches, and the volume of air passing up the flue averaged 1500 cubic feet per hour.

After the stove had been raised (40 inches from the floor), the total energy radiated from the stove was determined, and the mean of Experiments Nos. 6 to 11 was found to be 31 per cent. of the total heat generated in the stove.

From general observations of the thermopile readings obtained to the end of Experiment 11, it appeared as if more energy were radiated above the stove than below it. It was thought that this must be wrong, as by inspection the under-surface of the fuel appeared hotter than the top. For this reason there was every justification for raising the equatorial line and the radiometer so that their centres were in a horizontal line with the centre of the stove. Although this, obviously, would make very little difference to the total energy found as radiated, it would considerably alter that found as being radiated above the floor-level. This can be seen to be the case by comparing the figures obtained in experiments Nos. 11 and 12. In all probability the discrepancy of 1·8 per cent. in Column G is due to changes in calorific value of the gas during the experiments, as they were done under the same conditions in all other respects, taking place concurrently. In Experiments Nos. 13 and 14, the effect on the radiation of increased ventilation up the flue caused by putting the fan at full speed, was tried. About 1900 cubic feet of air passed through the top of the stove per hour; but no appreciable difference in the amount of energy radiated occurred. The calorific value in Experiment No. 13 is abnormally low, and could only be temporary. This will account for the slightly higher figure in Columns G and H.

In Experiments Nos. 15 to 20, the fan was turned off completely, and the size of the stop slightly varied. Ventilation was reduced to about 500 cubic feet per hour, but no difference of note in radiation was brought about by decreasing the draught up the flue. From this it is concluded that radiation is not influenced by changes of draught up the flue. This is because the volume of air pressing up the flue did not come into contact with the radiating surface, but passed in at the top of the stove. It is reasonable to conclude then that, under the conditions of these experiments, the amount of energy radiated from the stove lay between 30 and 33 per cent. of the total energy generated by the stove. Of this, about 25 per cent. was radiated above the floor level. In Experiment No. 21, a reflector was placed at the foot of the stove, and, as will be seen by reference to Column G, the amount of energy radiated above the floor-level was increased to 28·6 per cent.

It is interesting and extremely suggestive to note what happened during the process of combustion. The gas mixed with air left the bunsens, and was lighted. At first the flame was comparatively short, and heated the inner surface of the fuel. As this became hotter, the flame lengthened until it reached the top of the fuel, the edge of the outer cone of the flame playing on the inner surface of the fuel. The fire-clay began to radiate in all directions. The radiations from the back of the fuel were sent out into the room, except those that were intercepted by the front of the fuel. These were not altogether lost to the room, but were re-radiated to the back surface of the stove, raising its temperature and consequently its radiating power. The bulkier parts of the front of the fuel did, however, affect the radiations sent into the room, as shown by thermopile readings taken over the whole surface of the stove.

These parts are generally found on the left-hand side of each piece of fuel (fig. 4); and it is worthy of note that in all experiments the readings at 20° and 40° to the left of the stove were a little lower than those 20° and 40° to the right (see Table IV.). This would seem to indicate that either the front of the fuel should be much thinner, in order that it might attain a higher temperature and therefore emit more radiations, or that it should be made more open and the back of the fuel more compact, so that more direct radiations would be sent into the room. The temperature of the products of combustion, on leaving the stove, varied with the volume of air passing through the stove-flue. Should the house-flue be closed except for the stove-pipe, the suction on the stove-flue will be very great, and the flue loss of heat correspondingly high. Should, however, the house-flue be open and the stove-flue about 4 feet in length, with its entrance restricted, there will be a smaller volume of air passing through the stove-flue, but an increased ventilation up the house-flue.

Experimenters have often tried the effect of preheating the air that is used in the combustion of the gas; but so far as is known, no one has seriously tried the effect of also preheating the gas before mixing with the air. There is no reason why it should not enter the bunsens at the temperature of the escaping products of combustion (93° to 100° C.). A certain proportion of the heat will always be required for the purpose of carrying away the waste gases; but 3000 B.Th.U. per hour is excessive. There is ample scope here for further experimental work.

Determinations were made of the amount of heat passing directly up the flue and lost to the room. It will be seen by referring to Columns B, F, and K that this was proportional to the volume of air passing up the flue.

B.	F.	K.
Fan off	19 per cent.	500 cubic feet of air
,, half on	30 ,, ,,	1500 ,, ,, ,, ,,
,, full on	42 ,, ,,	1900 ,, ,, ,, ,,

About 40 per cent. of the heat generated by this type of stove was heat of convection and conduction—viz., that neither radiated nor passing up the flue. This, as well as the radiated energy, was available for heating the room. The energy radiated into the room struck the walls and furniture in the room, and was converted into molecular energy. The air was warmed by contact with the warm walls, &c., and by passing over the stove. The air of the room was heated very little by the radiations passing through it, but very much by its passing over the objects in the room which had been heated by radiated energy. In this way, radiant energy became convected heat. This quantity increased with the volume of air passing through the room. It can be seen from Table I., Column I, that the percentage of heat used in warming the air of the room increased with the volume of air passing through the room.

B.	K.	I.
Fan full on	2100 cubic feet.	11·48 per cent.
,, ,, ,,	1760 ,, ,,	9·16 ,, ,,
,, half ,,	1500 ,, ,,	8·15 ,, ,,
,, off	538·6 ,, ,,	4·08 ,, ,,

The temperature of the air passing through the room rose as the volume of air decreased (Columns K and O). The volume and temperature being known (Columns K and O), a simple calculation gives the volume of air that might be heated from 45° to 60° Fahr. (Column J.)

Vitiation of the Atmosphere by Means of Carbon Dioxide from the Stove.—Whenever the volume of air passing up the flue fell below about 1000 cubic feet per hour, the amount of carbon dioxide escaping into the room increased considerably, whereas above 1300 cubic feet the escape was only very slight indeed (Experiments Nos. 1 to 14, Columns Q and R). In no case, even in the small room used, and with the abnormally low ventilation as existed in Experiments Nos. 15 to 18, was the amount of carbon dioxide greater than 6·2 parts per 10,000. Carbon monoxide was very carefully looked for. Blank tests were made with the outer air, and slight discolorations of the chloroform occurred. In no case did the room air show a deeper colour than the blank, and only when ventilation up the flue had been very much restricted, as in Experiments Nos. 15 to 18, was any found in the flue gases (see Columns S and T).

As the ventilation experiments were always run over night, and lasted from 15 to 20 hours, it was ensured that conditions had become constant. During the whole time samples of (1) the room gases, (2) the flue gases, and (3) the coal gas burnt, were being collected for analysis. The room was never entered during the experiment; and all temperature and hygrometer readings were taken from outside. At the end of the experiments the manipulator entered the room by means of the double door, letting in as little cold air as possible. In this way the "smell test" could be determined. Only in Experiments Nos. 15 to 18 was the smell and heaviness of the room air unpleasant. This might be due to (1) the percentage humidity being so low (Column W), (2) to the high temperature, (3) to the presence of carbon dioxide.

On referring to Columns V to Y in Table I., it will be seen the percentage humidity of the room decreased with the rise in temperature (Experiments Nos. 15 to 17), though the percentage increase in the weight of water vapour present per cubic foot of air was higher. This was to be expected. It was stated in the report of the Smoke Abatement Society's research (1906) that a humidity of 58 to 72 per cent. at 15° C. is agreeable. It will be seen that the average room temperature in all these experiments was

abnormally high, being 25° C. At 15° C., the percentage humidity would increase to within this agreeable limit. If the radiating efficiency of the stove were increased, the amount of convected and conducted heat would be less, and although less heat would go to raising the temperature of the air of the room, more would go directly to warming the walls and objects about the room. This would mean that the "drying" effect would not be so great.

The radiating efficiency of the so-called gas radiators, with open fires, was determined (see Experiments Nos. 22 and 23). In the case of the large type of condensing stove (22), it will be seen that they radiate about 25 per cent. of their heat, and with the smaller type 22 per cent. This could be increased by doing away with the ironwork in front of the radiating surface.

Summarizing, it has been found that:—

1.—The total radiation from an open gas-fire is about 32 per cent.; and this is unaffected by the amount of ventilation through the room.

2.—No carbon monoxide escapes under ordinary conditions into the room, and very little is ever found in the flue.

3.—About 30 per cent. of the heat generated in the stove passes directly into the flue. This figure varies with the volume of air passing through the stove flue.

4.—There is no necessity for products of combustion to enter the room and cause discomfort.

5.—Reflectors may be usefully employed to produce a sensible increase of radiation into the region where it is most wanted.

Discussion.

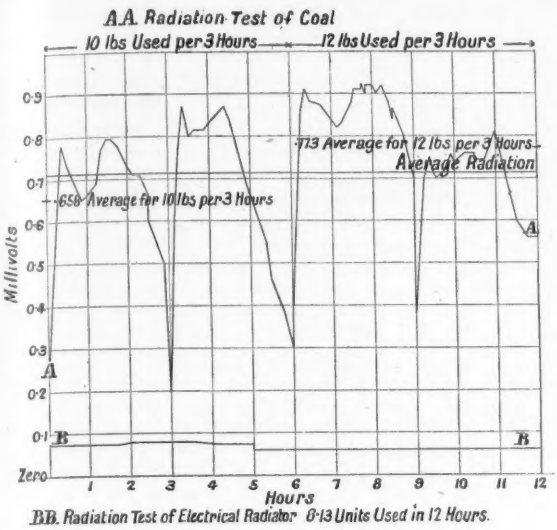
The PRESIDENT said the report had been very well summarized by Mr. Smith; and they now had a grip of what the trade were doing. It was most important that this work should be standardized, so that makers should know what to aim at in devising a gas-stove. One thing he might take exception to was in respect to the effect of ventilation on the radiating power of the fuel. It seemed to him that if one had an excessive pull on the chimney, had the fire closed in, and the flue provided was too large for the opening, the amount of air drawn in through the fire would seriously affect the radiating power of the fuel. The heat would go up the chimney instead of being converted into radiant heat. The conditions constantly differed; they might be quite different in two houses. The amount of pull on the chimney to which the fire was attached considerably affected its efficiency; so that makers had to pay attention to the size of the flue-opening they provided. It was very important that 52 per cent. of radiation should be attained, and the loss of heat going up the chimney from such an expensive fuel as gas should be reduced as much as possible. But, at the same time, they did not want the products of combustion in the room. Mr. Smith admitted that in introducing this fire under nearly perfect conditions there was emitted a small quantity of carbon dioxide. This ought not to be there. If the fire were provided with sufficient canopy, and the flue opening was sufficient, the products of combustion ought to be entirely removed. If they had carbon dioxide, the combustion was not going on under proper conditions, and they were almost certain to get carbon monoxide also; whereas they ought to be able to assure consumers that such things would not happen. There was no doubt that stove-makers had all their work to do to meet the requirements of the public; but the Research Committee were doing much to help them.

Mr. JOHN BOND (Southport) said they were much indebted to Professor Smithells, the Chairman of the Research Committee, Mr. Smith, the Research Chemist, and the other members of the University of Leeds staff for the great amount of valuable information which had been compiled in so short a period. The preliminary work, which naturally took up a lot of time, had been got over, and a good foundation laid for future research. The gas-fire of the ordinary radiating type used for domestic purposes had a keen competitor in coal, although, as the President had pointed out in his address, there were grave disadvantages attaching to the use of bituminous coal as a fuel for heating purposes. He (the speaker) had made a large number of tests, and had shown in the results the cost of radiant energy from different radiating sources. These tests were made by means of the Rubens thermopile and an ordinary delicate galvanometer having a suspended coil and mirror; and the records were photographed during the tests. From these photographs, he was able to produce a number of slides, which he would be pleased to have thrown on the screen. [These will be found reproduced on p. 829.] No. 1 diagram showed the radiating curve and the average radiation of a coal-fire, where the coal was placed in the grate at the rate of 10 to 12 lbs. every three hours. No. 2 gave the radiation of a coal-fire, when the coal was placed in the grate at the rate of 4 lbs. each hour; and also the average radiation. It would be noticed that this diagram illustrated how the radiation died down after no further addition of coal at the eighth hour. In No. 3, the total quantity of coke used amounted to 32 lbs.; and this was placed on the fire at the different rates shown at the top of the diagram. The average radiation of the anthracite fire, as shown on diagram No. 4, was very low. This was due chiefly to the fire having a closed mica front; but, of course, the principal heating source of an anthracite fire was due to convected heat. On diagram No. 5, the curve BB showed how evenly the radiant energy was given from a gas-fire; and, had the pressure not varied after 5½ hours, the curve would have been still more regular. Curve CC gave the pressure; and curve AA showed the calorific value of the gas, which was taken from a photographic record given by a Boys calorimeter fitted with thermocouples. The radiation from the electric radiator was shown on diagram No. 1, line B B. The amount of radiation, as would be seen, was low; and taking the cost of electricity at the rate of 2d. per unit, or lower, the gas industry had not much to fear from this competitor. It must be distinctly understood that heat of convection had not been considered; and figures regarding cost could not be taken as referring to the total efficiency in comparing the gas-fire with other means of heating. It would be noticed in a table which he would hand in later [and which we reproduce below] that, for a twelve-hours run, whereas the radiant energy from coal (at, say, 21s. per ton) cost 3·46d. to 3·49d., the radiant energy from a gas-fire, taking gas at 2s. 6d. per 1000 cubic feet, cost 15·34d. No labour had been considered in the taking out of these costs for a twelve-hours run; but it was evident that the labour could make material difference in comparisons for short periods, as it would be necessary in the case of a coal, coke, or anthracite fire to add all the

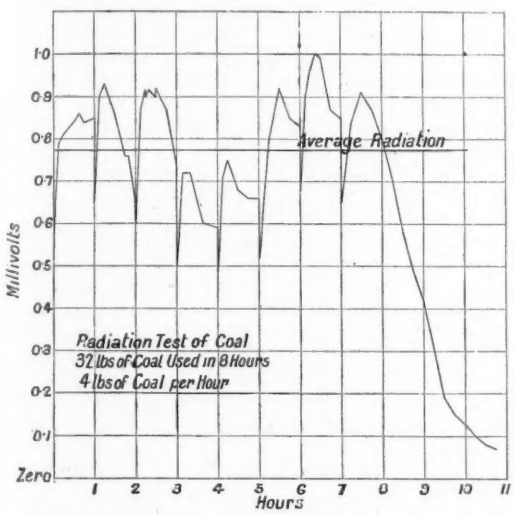
TABLE *Showing the Radiant Energy from Various Radiating Sources.*

Radiating Source.	Calorific Value.	Ash in Material.	Moisture in Material.	Total Quantity Used.	Average Radiation at a Distance of 8 Feet from the Source. Millivolts.	Quantity to Produce 0·5 Millivolt Radiation at 8 Feet from the Source during Twelve Hours.	Rate.	Cost for Twelve Hours to Obtain an Average Radiation of 0·5 Millivolt at 8 Feet from the Source.
1.—Coal (consumed in ordinary fire)	14,200 B.Th.U. per lb.	2·13	1·88	44 lbs. in 12 hrs.	0·714	30·80 lbs.	21s. per ton	3·46d. (*a*)
2.—Coal (consumed in ordinary fire)	14,200 B.Th.U. per lb.	2·13	1·88	32 lbs. in 8 hrs.	0·773	31·05 lbs.	21s. ,,	3·49d. (*b*)
3.—Coke (consumed in ordinary fire)	13,200 B.Th.U. per lb.	6·15	5·43	32 lbs. in 12 hrs.	0·555	28·80 lbs.	12s. 8d. ,,	1·95d. (*c*)
4.—Anthracite (consumed in anthracite fire)	13,800 B.Th.U. per lb.	3 12	2·16	20 lbs. in 10 hrs.	0·154	77·90 lbs.	40s. ,,	16·69d. (*d*)
5.—Gas (consumed in "Canopy" gas-fire)	578 B.Th.U. gross	..	..	243 cub. ft. in 10 hrs.	0·285	511·50 cub. ft.	2s. 6d. per 1000 c. ft.	15·34d. (*e*)
6.—Electricity (used in electric radiator)	..	..	..	8·13 units in 12 hrs.	0·067	60·70 units	2d. per unit.	121·4d.

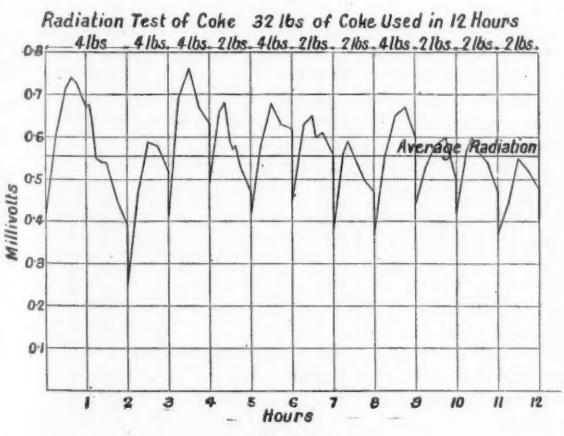
Remarks.—(*a*) 10 and 12 lbs. charged every three hours. (*b*) 4 lbs. charged every hour. (*c*) 2 to 4 lbs. charged every hour. (*d*) 2 lbs charged every hour. (*e*) Gas corrected to 60° F. + 30·0" pressure.


A.A. Radiation Test of Coal
10 lbs Used per 3 Hours
12 lbs Used per 3 Hours
·713 Average for 12 lbs per 3 Hours
Average Radiation
·658 Average for 10 lbs per 3 Hours
Millivolts
Zero
Hours
BB. Radiation Test of Electrical Radiator 0·13 Units Used in 12 Hours.

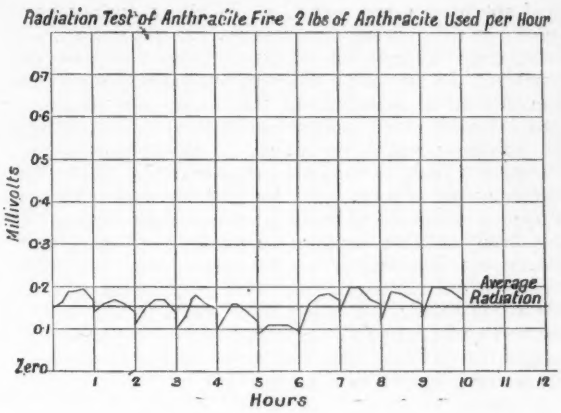
No. 1 and No. 6.



No. 2.



No. 3.



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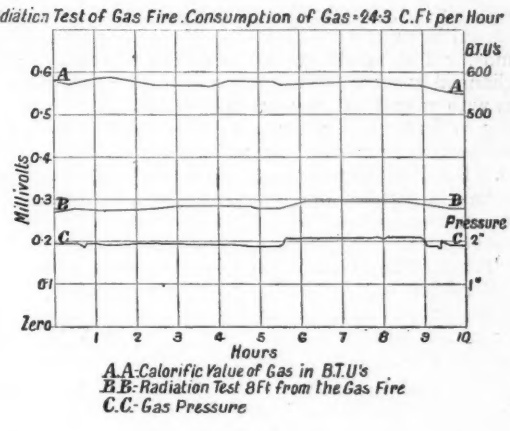

No. 5.

inconveniences of building-up and lighting and removal of the ashes and dust. In conclusion, he wished to emphasize the necessity of carrying on the gas-heating research so that all points in connection with gas heating could be worked out on sound scientific lines.

The PRESIDENT said they were much obliged to Mr. Bond for his addition to the paper. He thought they might now hear something from a manufacturer.

Mr. H. J. YATES (of John Wright and Eagle Range Company, Limited) said he greatly appreciated the opportunity afforded him of taking part in the discussion. It seemed to him that if the experiment-room had been somewhat larger, it might have helped the tests very much. He felt great difficulty, as a manufacturer, in speaking on a subject like this, because one was compelled to keep to himself a great deal of what he did. However well disposed he might be to his competitors, he had to make his living, and he could not give away all his information. Engineers were differently placed. If one discovered anything, he could give it away without fear of doing damage to his company. Radiation was undoubtedly the right form of heating for a living-room; and this opinion had been confirmed by Mr. Smith's paper. With convection, they had a drying atmosphere, but with radiation a fairly humid one. While on this subject, he should like to ask Mr. Smith, with regard to Table I., showing the difference between the outside and the inside percentages of humidity, if he was right in assuming that the difference was largely due to the difference of pressure. Taking the weight of water vapour present per cubic foot of air, the apparent difference in the percentage inside and outside led to the supposition that water had been introduced inside.

Mr. SMITH said that was so. The radiator necessitated having water in the room; and the higher the temperature of the air in the room, the greater was the amount of water vapour added to the atmosphere.

Mr. YATES said he thought the tests carried out by Mr. Smith taught a great deal; but he did not agree with him that it was advisable to get the radiation high up. They wanted to get the heat on the floor, because heat would naturally rise. Dealing with the question of the flue and the waste heat, if they increased the radiation, as they could do considerably with a flue when properly constructed, there would be no need to restrict it at all. They could send a large volume of air over the fire without interfering with the radiation. This was a matter which was not generally appreciated by stove-makers, who had an idea that if they carried a large amount of air up the flue they were cooling down the fire. In many cases this was so; but if the stove-makers constructed their stoves properly, they might carry a large volume of air over the fire without interfering with the heating capacity, and thus have a pure atmosphere in the room with no possibility of carbon monoxide escaping. In this way, the fire-place could always be entirely covered up; and they could get their ventilation right over the top of the refractory fuel. If they had a bad chimney, they

could not make a good one of it. Whether it was a gas or a coal fire, they would have trouble. It was not a remedy for a smoky chimney, as builders sometimes said, to put in a gas-fire. In the course of the paper, the author said that, from general observations of the thermopile readings, it appeared as if more energy was radiated above the stove than below it; and Table IV. was quoted as typical. This showed that the thermopile readings were all higher above the grate than below it. Mr. Smith spoke of there being no escape of carbonic oxide as long as things were perfect. This brought them back to the question of maintenance. There were fires made at the present day from which, if kept in order, no carbonic oxide was given off when they were lighted; but if they were left for the whole of the summer, and damp and dust were allowed to collect, and some of the fuel was fractured when lighted in the winter, they would give it off and cause dissatisfaction. If a periodical examination were made before they were brought into use again, there would be far less complaint. Then came the important question of the composition of the fuel. He had experimented for a good many years with refractory materials; but, unfortunately, all his theories had not been borne out by practice. He had tried various chemical compounds, and also endeavoured to increase the radiation by mechanical means. Mr. Smith had made several suggestions with regard to shapes; and he (Mr. Yates) had been trying to find some of his old experiments, and the iron models which he made of the various types of fuel he had used. But that now made, after the application of all the tests he had been able to apply, was, he believed, the most effective, from the radiation point of view. The fuel-guard was undoubtedly an obstruction to radiation, and therefore he omitted it altogether. But he had obtained a patent for it. The President was the first engineer he was acquainted with who really appreciated and knew what was wanted in shallow fires; and he had the pleasure, many years ago, of making some of the first shallow fires, long before they were known or offered to the public. Somehow they did not seem to "take on;" but what Mr. Glover thought then had been well borne out, and was now the order of the day. A great mistake was made with regard to fixing gas-fires in a room. They often replaced a 16-inch or 18-inch coal-grate with a 10-inch gas-fire; and then people said it did not heat the room. They should first ascertain the number of heat units it was possible to get out of a given fire; and then find the contents of the room, and the number of units required to heat it to a given temperature. This was the only satisfactory way of fixing any apparatus; and if they went to a heating contractor with hot-water pipes or a circulating radiator, this was his practice. It was not, however, followed with regard to gas-stoves. Another question was the cost of improvements. There was too much striving after cheapness. If they wanted a good apparatus, and the manufacturer had spent some time in improving and developing things, they must expect to pay for it; but some people were inclined to "go for" another stove which was 6d. cheaper from the first maker who came along. He hoped these things would be borne in mind. But there was a great deal yet to be done in the development of gas heating; and it could only be accomplished with the aid of the profession.

Mr. J. H. Brearley (Longwood) said he would rather listen to any suggestions from members of the Institution with respect to the work the Committee should undertake than speak himself. But, as he had done something in the direction alluded to in the paper, they might like to know what he thought about the work accomplished to the present time. Personally, he had been immensely fascinated by the scientific and the careful manner in which Mr. Smith had carried out his investigations into the estimation of radiant energy sensible as heat. One suggestion he would make was that makers should all set up in their laboratories similar apparatus to that described, and experiment on their own gas-fires; for one investigation of this kind was not really sufficient. The progress was necessarily slow; and if there were any members who had not conducted researches of this kind, they should remember that, though the work done by the Committee was very small, if they could manage to increase the radiant duty of the fuel even 1 per cent., the whole cost of the research would be amply repaid. The effect of such research as this could not be very easily seen. The makers had been somewhat stirred up during the last three years; and the report before the meeting would stir them up still further. He was quite sure that in Mr. Smith they had an admirable investigator; and it would be a great pity if the work was not continued till they had something better in the shape of gaseous heat.

Mr. J. W. Wilson (Leeds) said gas-stove manufacturers could only view this investigation with great satisfaction, for it was very much needed. They made gas-fires, and took them round and showed them to the managers of gas undertakings. But there was no standard of utility; and in this respect they were at a great disadvantage compared with their friends dealing with lighting apparatus. The lighting man had no difficulty in showing the capabilities of his light, but the gas-fire man had to a great extent to rely on his imagination; and there was much difficulty in comparing results. The consequence very often was that the firm with the best imagination was the most successful. This investigation was certainly in the right direction. It was something for stove-makers to know that they would be brought to book if they said they could do more than gas was capable of doing. They would be compelled to keep within the bounds of truth; and the public would not be disappointed when they got the stoves. He did not suggest that they wilfully misstated any of the results; but there was a certain latitude allowed to the imagination which did not conduce to success. There was no reason why the Research Committee could not be used as a medium for making tests for stoves; so that a maker could send his stove to them, get a testimonial, and then be allowed to advertise that his fire had been tested by the Committee with certain results. With reference to the loss of heat, why should not a standard loss be adopted? Instead of losing 30 per cent., the average loss should not exceed 15 or 10 per cent.; and no stove should be sold by the gas undertaking unless it came within this limit. He did not think 30 per cent. was very serious when one considered that the stove tested was the cheapest of its kind made. There were other stoves—take the condensing stove as an ideal—in which there was less loss; and others where the waste products were allowed to pass immediately away from the chimney. These, of course, were in a different class, which would give better results with regard to the total amount of heat obtained. Taking the full products of the gas-stove, they could reduce the flue temperature from 500° to 300° Fahr., and then the actual loss need not exceed 15 per cent. at the outside. There was some difficulty in criticizing the figures, as they had not appliances for doing so; but the result of about 30 per cent. lost heat was higher than in the test Mr. Brearley made last year. Referring to the question of lighting, he doubted whether there was as much light got out of gas for illuminating purposes as there was heat. When they came to the incandescent burner, the amount of heat that escaped was, roughly speaking, about half, without producing any light; so he did not think 30 per cent. was a serious loss.

Mr. H. Kendrick (Stretford) desired to add a word of thanks to the Committee and to Mr. Smith for the very useful work they had carried out; but there were one or two little points which he thought required clearing up. In the paper there was a typical analysis of the gas used in the experiment, which gave as the percentage of nitrogen the enormous figure of 16·27. Then a little farther on it was stated that "the net calorific value of the gas used in the experiment was about 1·42 calories." He emphasized the word "net," because he was very doubtful if, with a gas containing 16 per cent. of nitrogen, and with an illuminating power (obtained by a No. 2 "Metropolitan" burner) of 17·4 candles, they could get anything like this very high heat value. Taking some of the old figures, which were an average over the last three months, he found that 17-candle coal gas gave 1·45 calories gross and 1·28 calories net; but on mixing this gas with 20 per cent. of carburetted water gas, it was 144 gross and 131·5 net. His gas was half-a-calorie better than Leeds gas; so that he found it difficult to understand how the latter gas could be 11 calories higher than that at Stretford. Looking at Table I. in the appendix to the paper, and roughly going over some of the figures in columns F, G, H, and I, he could not make any of them total up to anything like 100; and he did not know where the balance had gone—whether any loss went up the flue, or on to the floor or anywhere else. Some of the figures totalled up to about 70; others to 130. He noticed, too, that the calorimetric value was still given as "net"—averaging 143 or 144 calories. It was evident that the mantle of the late Mr. Fletcher had fallen on Mr. Wilson's shoulders, and that they had a man who, though a manufacturer, was prepared to work in a scientific manner. He did not know before that they had an alarmist in their

camp; and he was surprised that Mr. Bond should tell them that heating by coal cost 3½d. per day, and by gas 16d., which was rather an astonishing statement. It might be for the same amount of radiation from the fire itself; but what occurred to him was whether the radiation was doing useful work—whether it was heating the air of the apartment. He thought he was correct in insisting that the amount of ventilation in coal-heated rooms was several times as much as in gas-heated rooms; and consequently a very great proportion of the heated air would be passing up the chimney instead of doing useful work in warming the room. On this account, a considerable correction should be made to the figures given by Mr. Bond. It was the same with regard to the humidity in the room. The apparent moist feeling in the air in a coal-heated apartment was not due to the large amount of moisture in the atmosphere, but to the very considerable quantity of cold air entering the room by every cranny of the doors and windows, reducing the temperature, and causing a feeling of moisture. Whereas with a gas-fire the air which passed up the flue was about one-fourth of that which went up the chimney with a coal-fire, and they had an apparent decrease in the moisture, this was simply due to the rising temperature increasing the capacity of the air for moisture, and a corresponding increase in the evaporation of the moisture from the skin causing a feeling of dryness. One other statement in the paper he did not understand. Mr. Smith said the result of imperfect combustion was a smell of carbon monoxide in the room. It was a long time since he had his lessons in chemistry, but he had a distinct recollection of being told that carbon monoxide had no smell at all. Probably Mr. Smith meant the smell of acetylene. He (Mr. Kendrick) had made some experiments with gas-fires, not with the view of testing the radiation in the manner now put before the members, but of trying to find which was the most efficient under actual working conditions, which could hardly be said of those obtaining in the tests described. He used his own office at the works, the door of which was open pretty frequently; and there he kept thermometers and also a thermopile with a galvanometer. He found that by using various types of fires he obtained a very different result for the same consumption of gas; and by using various types of fuel there was a very distinct difference. Taking the type of fire shown on the screen, he took the galvanometer readings with series up to 8 feet, and with the same fire each time; but with different fuels and different conditions the readings were 24°, 28°, 25°, 22°, 23°, 27°, 24°, 26°, and 28°. Then he had a conversation with Mr. Wilson as to the manner in which a gas-fire should be worked; and he insisted that it should be so regulated as to give a roaring flame. He (Mr. Kendrick) tried the effect of this, with the result that he had an increase of radiation (though another maker to whom he put the same question absolutely denied the necessity) to the extent of about 15 per cent. They had often heard certain statements about reflectors, and one table in the paper showed that the amount of radiation from the under-surface had been very much higher than that from the top, and that thus, in the ordinary course of events, the heat dropped into the fender or inside the guard, and its heating effect in the room was lost. If a reflector were used, it would take up this heat, which would be otherwise lost, and throw it farther out. He had a distinct increase in radiational readings in the galvanometer up to 10 feet away from the fire; and at the same time the temperature readings with the thermometers increased at a considerable distance—showing that the reflectors had a distinct effect. He should like to suggest that one of the matters that might be looked into, in addition to the particular points which had been examined, would be the effect of heating at different rates of consumption. It seemed to him that the shape of the flame issuing from the burner had a considerable effect on the amount of radiation. If the gas were turned low at any time, the amount of radiation did not correspond with the consumption. There was also a difference between the present pattern of the single-row fuel fires and the old two-row fuel fires; and there was also the question of the advantage or disadvantage of the duplex burner. If every fire were fitted with a duplex burner, they would get the flexibility now lacking, and which the coal-fire could be always made to give if properly looked after.

Mr. A. Wilson (Glasgow) suggested that the Committee should combine some utility with their science, so as to make the testing of some use to the public as well as to gas engineers. Scientific figures were all very well to those who understood them; but unless they had comparative figures the public would not make much use of them. He suggested that they should also show comparisons with coal-fires. A little of this work had been done in Glasgow, and he thought it would bear good fruit. With regard to humidity and the drying of the atmosphere in the room, this did not convey anything to an outsider; but if they could tell him that they had exactly the same result from the heat of a coal-fire, and that a gas-fire caused no more drying than a coal-fire, he would understand it. This was what they had found—that there was some drying of the atmosphere both from the coal-fire and the gas-fire.

Dr. Arthur H. Elliott (Consolidated Gas Company, New York) said he had listened with a great deal of interest to the paper, as during past years he had done a lot of work on the subject himself; but he was still very much "mixed up" in his mind as to what he had arrived at. A great deal depended on how the subject was really looked at. He had made a great many calculations and experiments in houses which he had himself built, heating them by hot air, by steam, and by hot water; and they could have just as much divergence of opinion as to these methods as they could with regard to heating by gas. The thing that struck him about the report was the extreme care with which the work had been done. It was unique; and he wished to thank the Committee heartily for having put him into some kind of shape as to how to go at it on the other side of the water. The impression he obtained from the report was that about one-third of the heat was radiated out, and about one-third was lost up the chimney. But where the other third went he could not find out; and this was what had puzzled him. The Committee would probably be able to explain it; but, if not, he might suggest that they had better hunt for this other third. With regard to heating houses or rooms, it largely depended on what was wanted. If they wanted an open fire, which was the English method, they must make some provision for flickering flames, and so on. In America, they heated principally by steam and hot water; they did not care particularly about the flame. They had plenty of anthracite coal, and were using it up very rapidly—more rapidly than England was using up her bituminous coal. But the heating with anthracite coal was very wasteful of the heat units in the fuel. One could take the same stove and heat it with coke or anthracite; and the amount of fuel used, if it were anthracite, was very much more than if coke were used. The reason was obvious. The flue temperature in anthracite stoves would be about 500° or 600° Fahr.; but with a properly regulated coke-stove of the same type it would only be about 300° or perhaps 250° Fahr. There was a great saving at once. They had to get sufficient draught in the anthracite stove to blow it up, while they did not have to do so with coke. This was where many failed in getting coke used. They were trying to introduce coke-stoves just now into New York, with a view to competing with anthracite; and they were doing this because they had fixed a coke-stove which, as they called it, was "fool-proof"—in other words, they had restricted the amount of air which could possibly get through it. It gave sufficient heat to produce a good fire; but one could not open the "draught" any more—in fact, they tried to fix it so as to make it troublesome to open. They obtained this idea from M. Boscheron, Engineer at the Liége (France) Gas-Works. He noticed that he had a plate working on a thread in front of the stove, which was the only place where the air could get in. He (Dr. Elliott) remarked to him that this was rather troublesome; and he replied that this was just what they wanted. They did not want it easy to open the stoves, because people could change the draught too rapidly. Two stoves ran together in this way, and the results compared, per pound of fuel used, were 17 : 21—the anthracite being 21. With regard to the application of fires for heating, if they heated hot water with gas they got more out of it than if they heated up the simple stove. It had been perfectly possible, with a commercial apparatus in New York, to get into water 80 per cent. of the heat units in the gas. If they heated a current of water that heated the room or house, they utilized 80 per cent. of the entire heat units. In his judgment, this was the way out of the difficulty. Of course, the apparatus was more expensive than the common type, which even now would give 50 per cent.; while a gas-heater (not a geyser) would give 50 per cent. of the total heat units in the gas. If they used better apparatus, restricting the amouut of air given to the flame, but always giving it enough—and this could be calculated

with gas better than with any other fuel—the flue temperature would be low and constant, and the water would take up the heat.

Mr. WALTER GRAFTON (Glasgow) said, with regard to the table, when the full draught was put on he found that the greatest amount of it gave the greatest amount of efficiency, and that of the total heat recovered 80 per cent. was accounted for and 19·16 per cent. unaccounted for. As to the standard of comparison, it was obvious, if they wanted to convert consumers to the use of gas-fires, they must try to bring them as near as possible to the conditions of coal firing. From comparisons made in his own house, the room shown on the screen was a box closed up in every sense, and did not represent the normal conditions of living-rooms; and in this way it fell short of what they should put before a consumer as likely to be obtained with a gas-fire. Taking a coal-fire, he found the humidity was generally 15 per cent. less; but the grains of moisture per cubic foot were 0·4 greater than with a gas-fire. Again, he found the temperature of a room with a coal-fire was 12° to 15° higher than the outside temperature while maintaining the same conditions; but what were these conditions? From the results he had been able to draw up, he found, at least in a room with approximately 66° to 72° of humidity, that there was a comfortable temperature. They did not want the heat all taken away from the floor; they wanted the bottom of the room warmed as well as the top.

Professor SMITHELLS said, as Chairman of the Research Committee, he must say how gratified he and all the members of the Committee were by the manner in which the report had been received. They welcomed both the sympathetic observations which had been made and the criticisms which had been passed in the kindest possible way. There was a good deal to answer, and it was important that it should be answered; and probably the best plan would be to embody in a short memorandum, to be appended to the paper, a reply to the various questions raised. There was one general point, however, on which he should like to make an observation. Their object had been not to produce, at any rate at that meeting, a complete statement of the subject of heating by gas, but first of all to elicit the facts, and to show how they did so, and present them as a dry statement of scientific facts, not as arguments to be used in persuasion of a reluctant public to adopt heating by gas rather than by other methods. They knew the world was full of prejudice about all sorts of things and about gas heating in particular. There was a large section of the medical profession constantly making statements on the subject of heating by gas which would not bear examination. They had, he was afraid, womankind—not only the "new" women, but the "old" women as well—against them in the use of gas for heating. This was a serious thing; and it seemed to him that the time had come when, instead of relying on the persuasive statements of gas-stove makers on the one hand, or the obstructive or ill-considered statements of medical men on the other, they ought to have some authentic setting forth of the facts. This was the mission on which they had entered. To-day they had given only the first of their results in the form of what they believed was the first exact measurement of the radiation of heat given off by a gas-stove. He had used his influence to keep the report within the small compass in which it was submitted, and not at present to enter into the larger and more interesting question of heating by gas as a whole. If the Committee had justified their existence so far, they would go forward and discuss the question in all its aspects, and give the members material which they might present to the public in any way they pleased. But, at any rate, it would be an authentic statement of the merits and demerits of heating by gas.

Mr. SMITH has since submitted (in writing) the following remarks regarding the discussion on his paper: The measurements recorded in the report refer only to direct radiation and to the heat passing into the flue. The remaining portion of the heat, distributed by convection currents of air passing over the stove into the room, was not estimated. It can, in fact, only be ascertained by subtracting the sum of the radiated heat and that passing up the flue from the total thermal value of the gas burned. In considering the radiation from the stove, it must be remembered that the radiations do not appreciably warm the air through which they pass; but when they fall upon the walls, floor, and objects in the room, they are absorbed. The warmed surfaces thus produced partly re-radiate their heat; and part goes to heating the air which is in contact with them—thus giving rise to convection currents. A current of air passing in front of a radiating surface does not appreciably absorb radiations; but if it cools the radiating surface by conducting away heat, there will, of course, be less radiation. In all the experiments recorded, the air in excess of that required for combustion passed through the top of the stove and not over the radiating surface at all. Although the percentage of nitrogen was as stated in the report, the remaining components of the gas brought the calorific value undoubtedly up to the figures given. By the "carbon monoxide smell" is meant the smell of the products of incomplete combustion, which were invariably accompanied by carbon monoxide. Of course, the smell was due to other constituents than carbon monoxide.

PAPERS READ.

CARBONIZATION IN CHAMBER SETTINGS.

By R. LESSING, Ph.D., F.C.S.

It may fairly be assumed that the most difficult problem which beset the originator of the gas industry was the selection of a proper shape and size of the coal containing distillation vessel. Murdoch himself, after experimenting with crucibles, pots, and tubes set at various angles, finally adopted the form of horizontal retort, which to this day dominates the majority of the world's retort-houses. It was not until the latter part of the last century that successful steps were taken to depart from what had become a standard pattern; and the trend of invention led in various directions to modifications, alterations, and improvements. The regenerative furnace was introduced into the retort-house, and thereby more rational methods of heating were developed, which permitted great improvements in material, design, and working of the retorts. The labour-saving principle underlying Coze's inclined retorts challenged the inventive genius of advocates of horizontal retorts, thereby producing a number of mechanical devices for the charging and drawing of the latter, which are being constantly improved and added to by more efficient machines.

The most revolutionary movement, however, by which the industry was stirred in recent years was the coming of the vertical retort of various systems. Originally and mainly intended to introduce the principle of gravitation into the manipulation of gas-retorts, it soon became evident that the method comprised so marked advantages in many respects over the older systems, that it not only became firmly established within a very short period of time in a great number of works—most notably on the Continent of Europe—but at the same time advanced our ideas on the theory of carbonization to a considerable degree. Hardly had we realized that the vertical retort had successfully emerged from the experimental stage, and taken the field in the competitive struggle with the well-tried systems of longer standing, when news reached us of the laying down and working on the largest scale of plant on a principle until then unknown in the practice of gas-works. I refer to carbonization in large-space chambers.

If I attempt in the following lines to bring a few data on this subject before the members of the Institution of Gas Engineers, I trust I shall be forgiven for doing so without being in a position to submit that sufficiency of material and working results which I should consider desirable and indispensable evidence in forming a conclusive opinion for or against the system. This is due partly to a justifiable reticence on the part of some of the firms in possession of this material, but more so to the very limited period of time over which results are, as yet, available. My apology for bringing this subject before you at this comparatively premature stage lies in my belief that the extraordinary rapidity with which this system has found a footing, and spread over quite a large number of gas-works, is in itself a justification for a discussion of its merits.

The introduction of recovery plant into the coke-oven industry has made enormous strides during the last twenty years. The development of this industry has shown that coal can be carbonized in bulk, and the means of coking in a single receptacle a quantity of fifteen to twenty times the weight of coal charged into an ordinary gas-retort have been worked out to great perfection. The gas being the bye-product in coking practice, it is employed for the heating of the ovens; while with the gas-retort, the solid product serves

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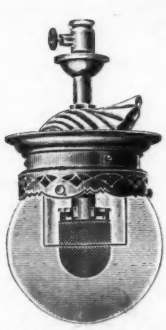

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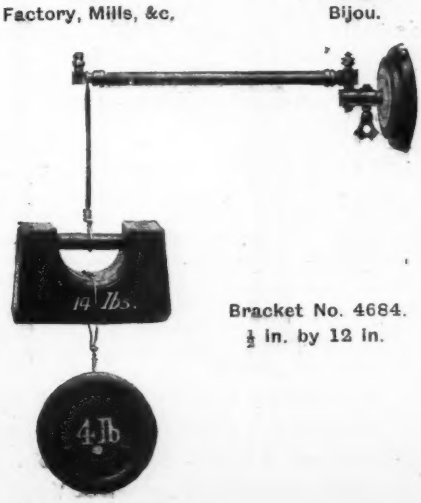

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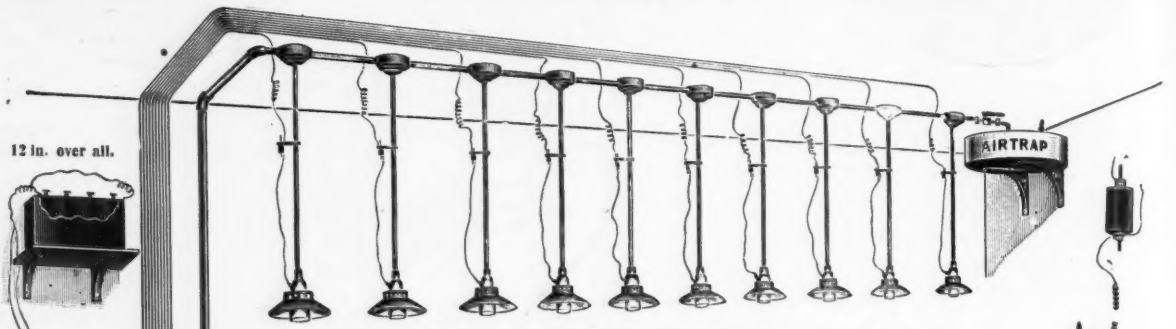

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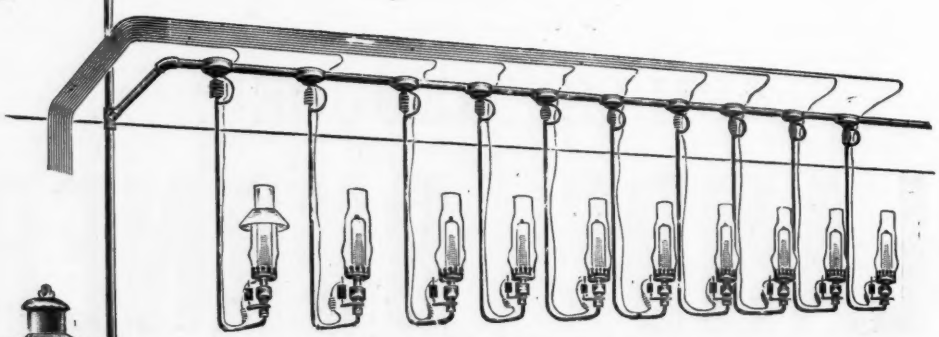

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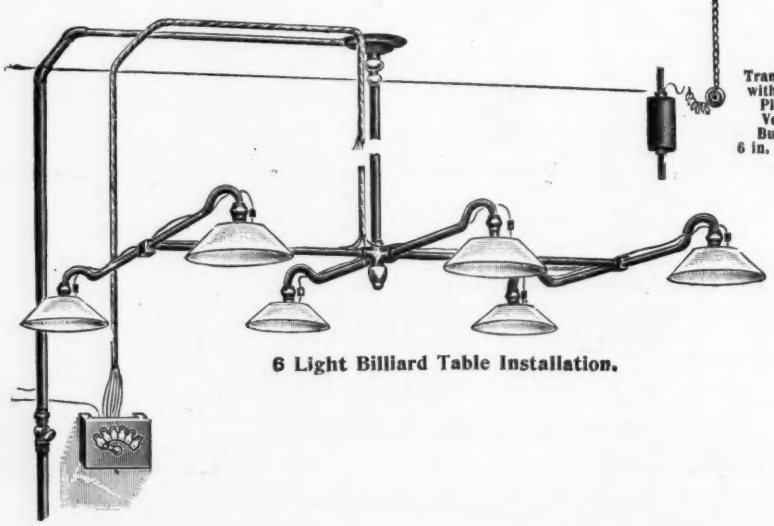

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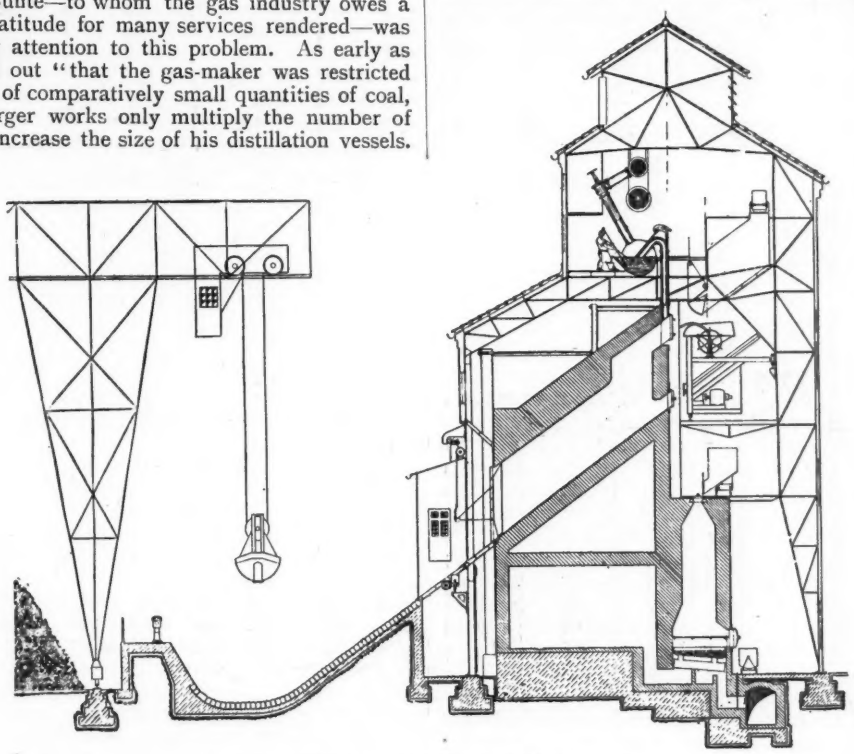
as fuel. There is no theoretical reason why, under equal conditions and with the same coal, there should not be made a gas of essentially the same character in both plants; the difference lying rather in the use of the products than in the making of them.

Of course, the practical differences are of very much greater importance. Surface action of the larger bulk of coal or coke, and the difficulty of keeping the brick-built chambers gastight, give a different aspect to the problem. The latter difficulty is, however, to a large extent due to the indifference of the coke-maker as to the quality of his gas—his mind being bent primarily on the quality of the coke. The fact, however, that coke-oven gas, either enriched with benzol, or else a richer fraction separated during the first period of coking, has been used in place of town gas in various places in this country and abroad (notably in the United States of America), showed that carbonization in bulk for the production of illuminating gas was a problem within the reach of possible execution.

Perhaps Dr. Bunte—to whom the gas industry owes a heavy debt of gratitude for many services rendered—was the first to draw attention to this problem. As early as 1894, he pointed out "that the gas-maker was restricted to the distillation of comparatively small quantities of coal, and could for larger works only multiply the number of retorts, but not increase the size of his distillation vessels.



Cross Section of the Munich Carbonizing Chamber.

If, however, enrichment of a crude gas with benzol would be resorted to, they were in a position to employ large distillation chambers, similar to recovery coke-ovens, which could be handled much simpler and cheaper than ordinary gas-retorts."

These casual remarks fell on fertile soil. Mr. H. Ries, the Engineer and Manager of the Munich Gas-Works, evolved during the following years (in collaboration with Dr. E. Schilling) a scheme for the working out of the problem; and to him is due the credit for having designed and put up the first large-space chambers for gas production. Towards the end of 1901—after a delay of several years caused by the transference of the works to the Municipality—he adapted an ordinary setting for inclined retorts in the old (now disused) Munich Gas-Works, to a setting of three chambers. They had a capacity of 1 ton each, and were set at an angle of 35° to the horizontal. Although the quality of the gas produced was not all that could be desired, the results were sufficiently encouraging to continue the experiments. The chamber space was increased to a capacity of 2·2 tons; and although this setting was also an adaptation only of an ordinary retort-furnace, the results were so satisfactory as to justify the laying down of large plant.

A bench of fifteen chambers, in five settings, was accordingly erected at the Kirchstein works of the Munich Corporation, and has been in almost continuous operation since Oct. 6, 1906.* This plant has been subjected to very exhaustive tests by Professor Bunte and his staff. Since the results of this examination, as well as those of a test by Professor Drehschmidt, comparing the chambers with Dessau vertical retorts have been fully published in the Technical Press, I need hardly enlarge on them. I should only like to draw your attention to one of Professor Bunte's diagrams, which gives a good idea of the general course of carbonization. In this case the charging of the chambers was effected within a few minutes, in order to obtain results representative of every stage of carbonization during the 24 hours.

On the whole, the results were regarded as satisfactory—the more so as an average illuminating power of from 10 to 12 candles is now-a-days considered sufficient by German experts as long as the calorific value lies somewhere above 5000 calories per cubic metre—equivalent to 560 B.Th.U. per cubic foot.

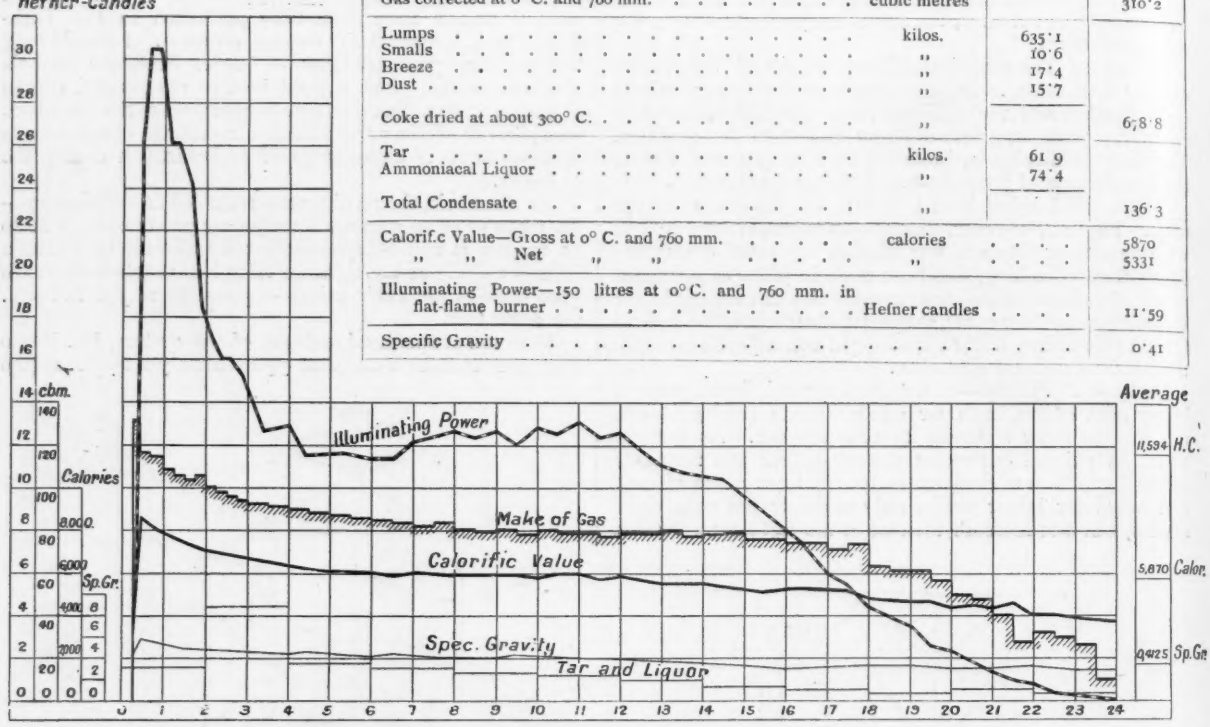
As to the common advantages of the system, Dr. Bunte calculates that for a make of 3½ millions per 24 hours (the maximum demands of the Munich works), the old Munich horizontal retorts would require 2376 charges, as against 123 charges of the chambers, with a consequent saving of labour, and smaller losses of gas upon charging and discharging. In the new plant, with twice the capacity per chamber, the contrast must be all the more striking.

The results of the working of this first large installation were sufficiently convincing for the authorities of the Hamburg Gas-Works to decide on the putting down of a battery of ten settings with nearly twice the capacity of the Munich Kirchstein chambers per setting. I have had an opportunity of giving a short description of the plant in the "Journal of Gas Lighting" for July 14, 1908; and therefore I need here not go into the constructional details of the system. The plant has been in operation for the last eight months, and has, as I understand, given entire satisfaction; but there is to hand so far no independent test of its efficiency. The heating economy of the system may be gathered from its fuel consumption, of 12 to 15 per cent. of the coal carbonized, with a yield of about 12,500 cubic feet of gas per ton—only English coal being employed.

With a capacity of 17·5 tons per setting of three chambers, as adopted in the Hamburg works, the maximum size of the unit was not reached. It is satisfactory to note that it was left to the first designer and initiator of the system, Mr. Ries, to proceed one step further, and still increase the capacity of the setting to 19·4 tons, as against 9·7 tons in the previous installation. In his able hands, the chamber setting was thus developed from the first experimental plant to a unit of from six to seven times its carbonizing space.

* An illustrated description of these carbonizing chambers appeared in the "Journal" for Aug. 13, 1906.

1000 Kilos. of Coal Yield.			
Gas corrected at 0° C. and 760 mm.	cubic metres		310·2
Lumps	kilos.	635·1	
Smalls	,,	10·6	
Breeze	,,	17·4	
Dust	,,	15·7	
Coke dried at about 300° C.	,,		678·8
Tar	kilos.	61·9	
Ammoniacal Liquor	,,	74·4	
Total Condensate	,,		136·3
Calorific Value—Gross at 0° C. and 760 mm.	calories		5870
,, ,, Net ,, ,,	,,		5331
Illuminating Power—150 litres at 0° C. and 760 mm. in flat-flame burner	Hefner candles		11·59
Specific Gravity			0·41



From his design a new works has sprung up during the last two years or so at Moosach on the outskirts of the Bavarian Capital, which in its general arrangement seems destined to serve as a model gas-works for years to come. It was my privilege to be shown over the works during the week when carbonizing operations started; and as far as one is able to judge from a two months' experience, the new carbonizing plant is likely to fulfil all expectations.

It consists so far of six settings of three chambers each; and a second bench of six settings is in course of erection. The increased carbonizing space was obtained by lengthening the chamber to 28·7 feet—corresponding to 23·4 feet on the horizontal (as against 24·6 feet and 21·5 feet and 16·4 and 13·6 feet respectively in the Hamburg and Kirchstein works), the chambers being set at an angle of 35° 55′. The height and width of the chambers are the same in plants of all sizes, in order to simplify the design of castings, and to obtain similar height and thickness of the layer of coal. The arrangement of a wider centre chamber and narrower outer chambers has also been retained, allowing the more concentrated heat in the middle to play on a thicker layer of coal.

The mechanical appliances have been worked out with great care, and have been simplified and improved after the experience gained with the previous plants. The coal is elevated to the top of the retort-house, and distributed in the bunkers which also serve as measuring vessels. On charging, the bunker is emptied over a portable shoot running on rails along the charging platform into the charging aperture of the chamber. The discharging is effected by pulling up the hinged bottom door, by means of a small crane, when the mass of about 4½ tons of coke easily glides over a similar shoot into the quenching tower. At the base of the tower is arranged a De Brouwer conveyor of only 23 feet length, which quickly carries the coke through and out of the tower—dropping it subsequently into a quenching pit over and along which the tower with conveyor attached is travelling on rails. Thence it is taken up by a crane working along a gantry, and distributed over the yard, or charged into the ferro-concrete bunkers, coke breaker, or railway trucks. Whereas the Hamburg chambers are standing in the open air (simply protected by a roof), the Munich plant has been housed in a light and lofty building. It is estimated that a saving of ½ per cent. in the fuel required to make up losses by radiation during the long and severe winter in the district, would approximately represent interest on the capital outlay for the retort-house.

I have already pointed out that it cannot be my task here to submit a complete set of working results. Results over a long period of time could only be obtained of the older Munich plant, carbonizing less than 50 tons per diem. And its run of only two-and-a-half years may be deemed rather insufficient by intending critics to draw any definite conclusions. But the most remarkable feature I wish to bring before you is the enormous rapidity with which the principle of large carbonizing spaces has been accepted in many quarters on the Continent with only this scant experience to support it.

To-day there are less than 350 tons of coal carbonized in chambers of the Munich system; and of these, 120 tons in a plant about eight months old, and 175 tons (or one-half) in a plant only eight weeks in operation. And yet there are works nearly completed, or under contract, with a total carbonizing capacity of upwards of 1500 tons per 24 hours—at Leipzic, Paris, Rome, Berlin, Hanau, Ratisbon, and Munich. Nor has the principle been restricted to this, the original design. The idea has been taken up by all the leading contractors for carbonizing plant in Germany. Nearly all the makers of this type of plant advertise, if not actually build, chamber-settings. Some of these designs have indeed assumed bodily shape; and I give a few photographs showing some of the works in operation, with a few details about them.

The majority of the works built so far have not departed from the inclined arrangement of the chambers. Messrs. Koppers (whom their experience in designing coke-ovens stood in good stead) have brought out a type the characteristic feature of which are the vertical flues which, independent in gas and air supply, allow a very even heating of the chamber walls. Openings on the top of each flue give access for inspecting the fire and regulating the combustion by means of sliding bricks.

A battery of seven inclined chambers of this type was put in operation at the Bochum Gas-Works on Sept. 1, 1908. They have a carbonizing capacity of about 56 tons per 24 hours, and make in this time about 90,000 cubic feet of gas per chamber, at the rate of rather more than 11,000 cubic feet per ton, of a net calorific value of 550 B.Th.U. The area covered by the whole plant (including coke bench and coal bunkers) is 3500 square feet, which works out at 180 cubic feet of gas made per square foot. The output of gas per man and per shift is nearly 100,000 cubic feet, which compares with 30,000 cubic feet on the inclined retort plant at the same works.

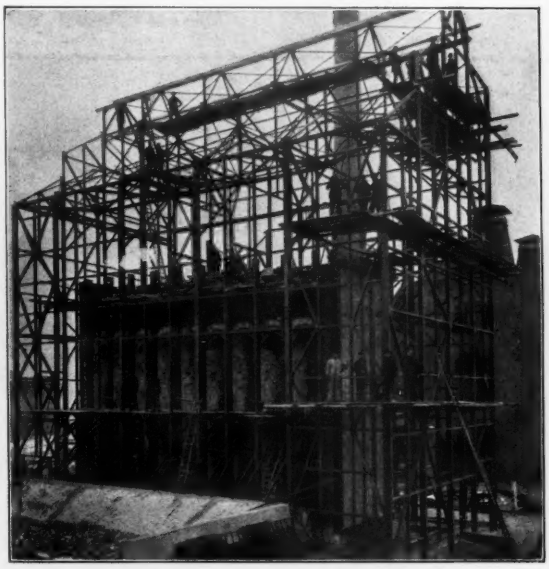
A battery of fifteen chambers has been erected at Vienna, and operations commenced there on Dec. 30, 1908. About

Battery of Koppers' Chamber-Ovens at the Bochum Gas-Works—Front View of Ovens.

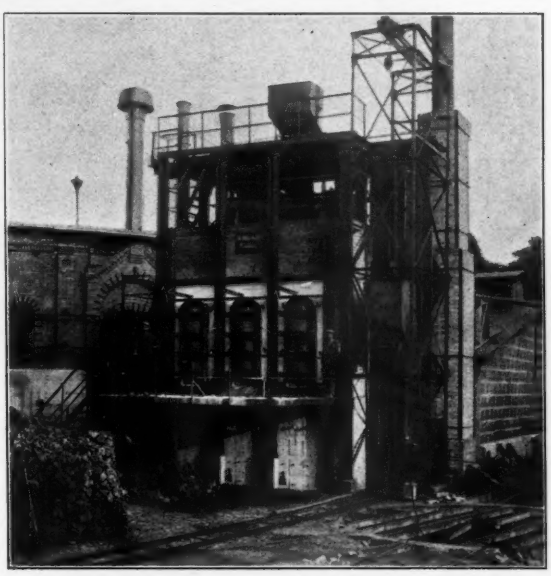
120 tons of coal are carbonized there per 24 hours, yielding 10,500 to 12,000 cubic feet of gas according to the kind of coal used. With a total area of 7000 square feet, 200 cubic feet of gas are made per square foot covered. The yield of gas per man employed per shift of from 8 to 10 hours equals upwards of 175,000 cubic feet.

Inclined chambers with vertical heating flues are also built by Messrs. Knoch. The special feature of this system (and on which particular stress is laid by the firm) is the absolute independence of each chamber. The chambers are not combined in threes or fours in one bed; but each chamber is enveloped in its own shell, and heated by its own flues—the heating gas being made, wherever possible, in a separate producer plant common to the whole installation. A plant at Halberstadt began working in April, 1908, and another one of nine chambers, and producing 350,000 cubic feet per 24 hours, with a charge of 3·4 tons per chamber, was erected at Boehlitz-Ehrenberg, near Leipzic.

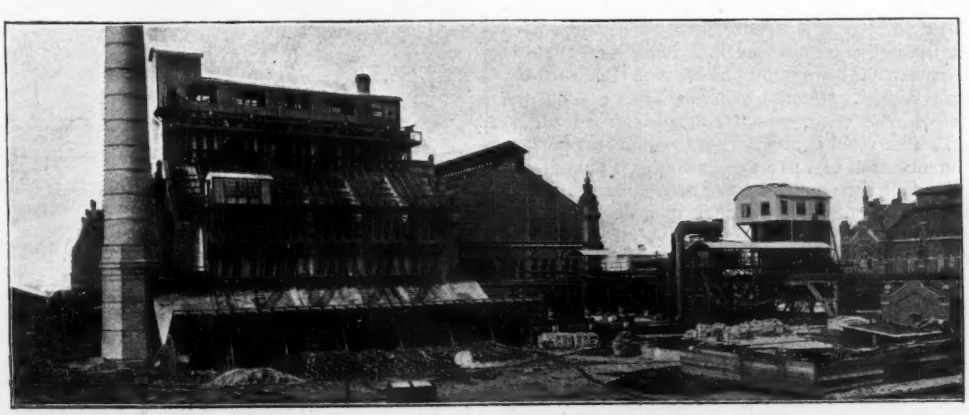
Messrs. Klönne—who had made an early, although an unsuccessful, attempt at chamber settings in 1892, at Schalke—have again turned their attention to chamber settings. While all the plants so far described are of the inclined type, this firm have constructed and are building plants of the inclined, horizontal, and vertical pattern. Two settings of four inclined chambers have been at work at Königsberg, in Prussia, since the beginning of the present year. With a



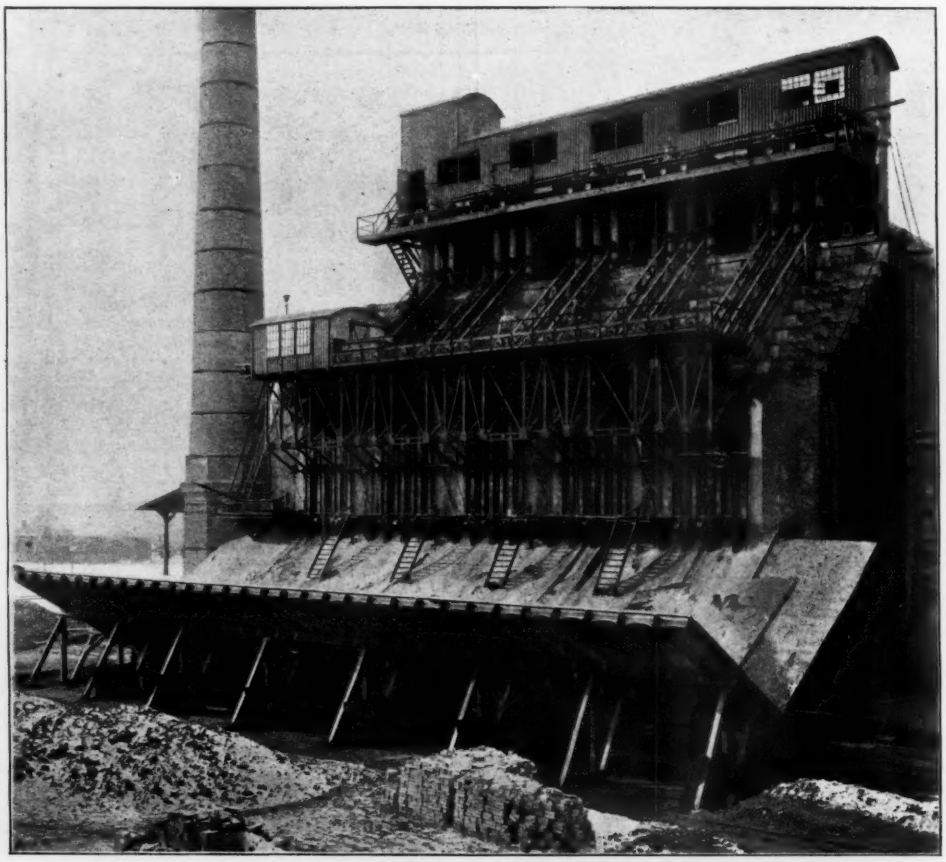
A Battery of Chamber-Ovens under Construction near Leipzig.



Knoch's Chamber-Ovens at Lauban.



Battery of Fifteen Koppers' Chamber-Ovens Erected at the Vienna Gas-Works, showing the Gas-Producer Plant on the Right.



Battery of Fifteen Koppers' Chambers at the Vienna Gas-Works.

carbonizing capacity up to 7·2 tons per chamber, the yield of gas is 11,500 to 12,000 cubic feet, of a net calorific value of 550 B.Th.U. The fuel consumed is 14 to 15 per cent. of the coal charged. The carbonizing wages at this works are said to have dropped from 9d. with inclined retorts to about ¾d. per 10,000 cubic feet of gas made in chambers. In consequence, four more settings of a capacity of 1,270,000 cubic feet are to be laid down at this place.

A specimen of the Klönne horizontal chambers has been at work at Rotterdam since Aug. 9, 1908. An illustrated article dealing with this plant, and giving working results, has been published by Mr. Sissingh, the Rotterdam Gas Engineer, in the "JOURNAL OF GAS LIGHTING" for Dec. 29, 1908, p. 902. I may therefore confine myself to saying that this is a setting of four chambers holding 2·75 tons of coal each, and making 12,000 cubic feet of gas per ton, of a calorific value of 560 B.Th.U. The coal is charged through two openings on top of the ovens from a travelling hopper; and the coke is discharged by means of an electrical ram—much after the fashion usual in coke-oven practice.

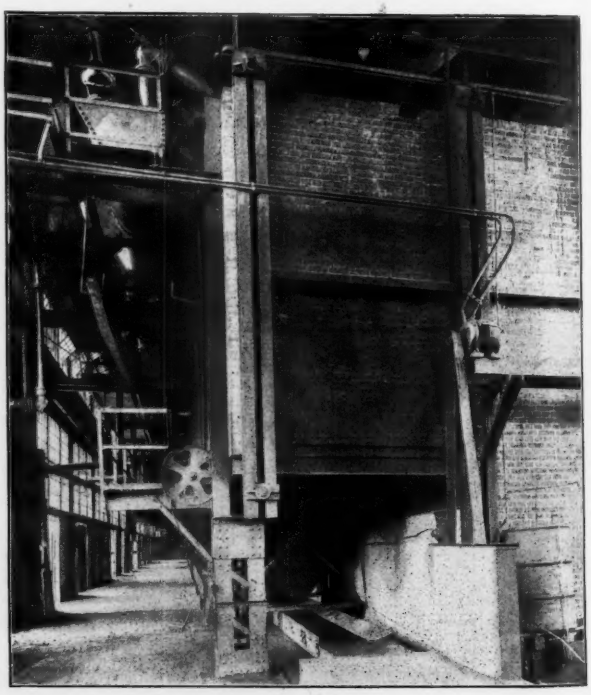
The horizontal chambers have the advantage of being about 30 per cent. cheaper than an inclined setting of the same capacity; and they do not require the more delicate manipulation desirable for the latter. However, they cannot compete in efficiency with the inclined settings at a make of more than 40,000 cubic feet per chamber.

A vertical furnace has been put up by Messrs. Klönne at the Dortmund Gas-Works. It contains five chambers, charged with 1·3 tons of coal each, which can be burned off in twelve hours. The yield is about 12,000 cubic feet per ton with a fuel consumption of 14 to 15 per cent. The make of gas is 550 cubic feet per square foot of area covered.

Messrs. Horn also build a vertical chamber-oven, for which many advantages are claimed. A plant of this design has recently been started at Hecklingen (Thuringia), of a daily capacity of 140,000 cubic feet which, so far, has worked satisfactorily.

CARBONIZING CHAMBERS IN ENGLAND.

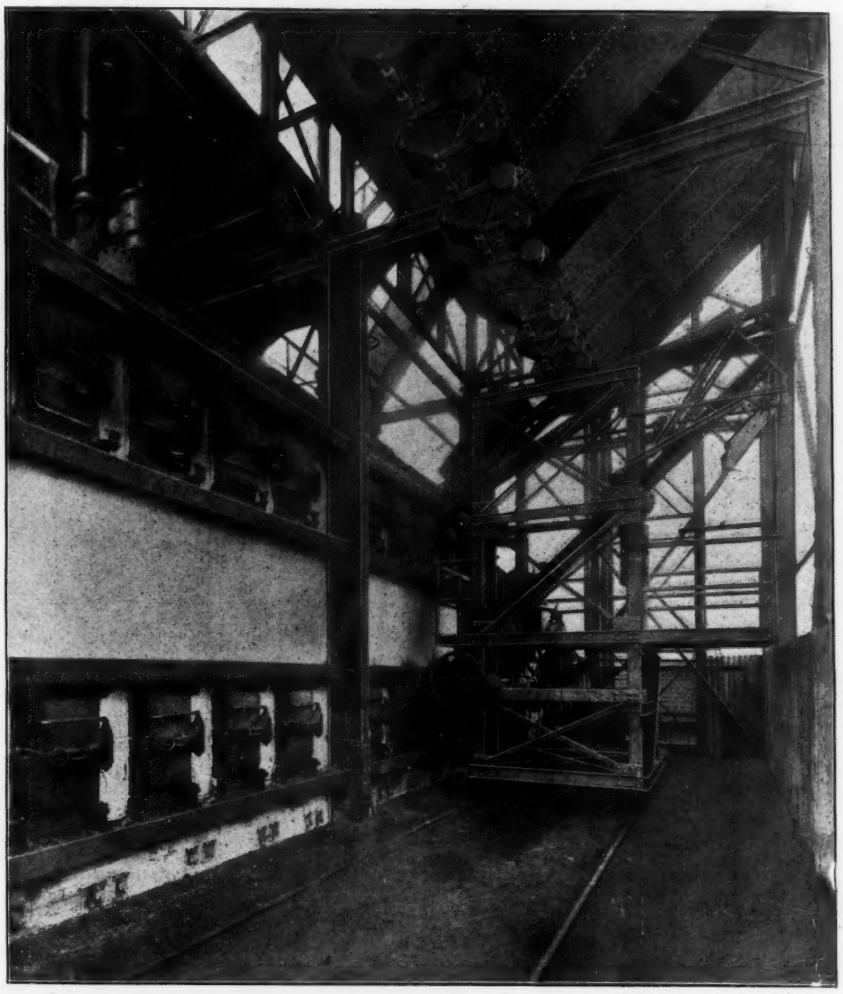
Having so far considered doings on the Continent only, it must by no means be assumed that British engineers have been idle in exploiting this most recent problem of the gas industry. It is only fair to point out that attention has been paid to the subject, though progress has hitherto not been



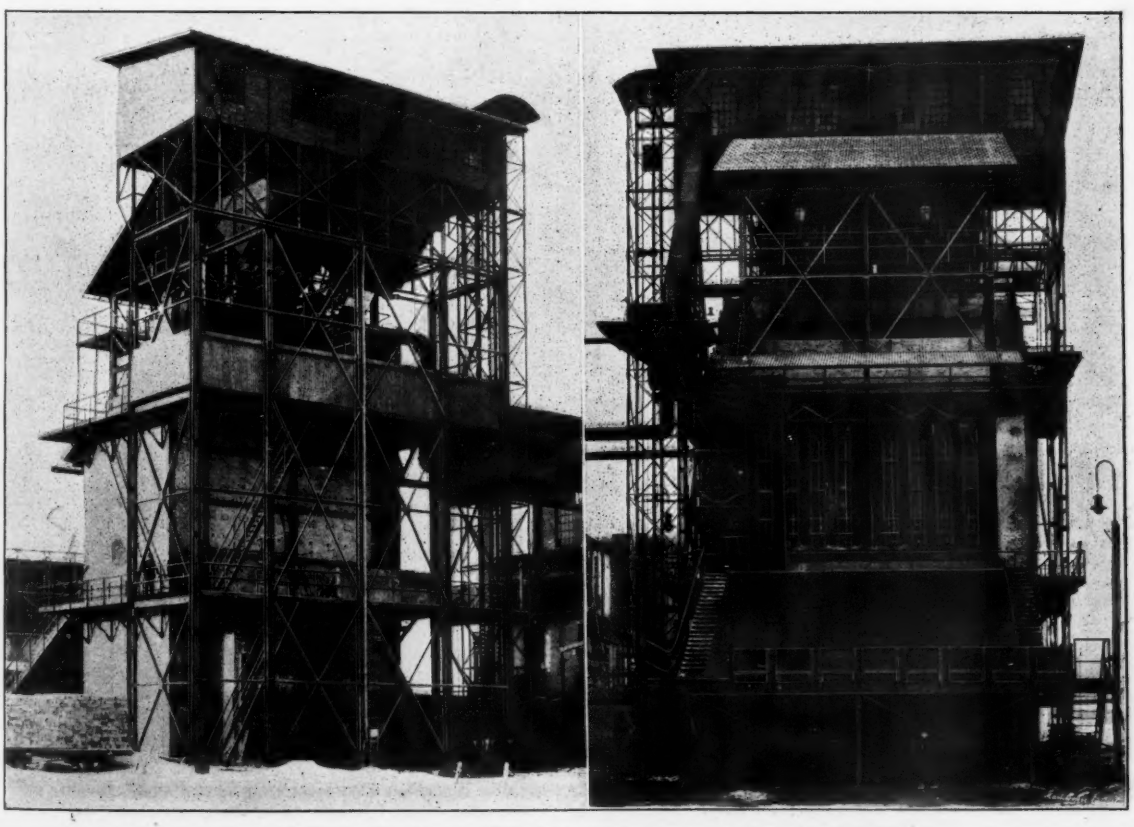
Klonne's Vertical Chamber Setting—Dortmund Gas-Works.

of as rapidly expanding a character as on the other side of the Channel. The Institution of Gas Engineers may be congratulated that their President was probably the first in this country to recognize the possibilities of carbonization in bulk. It is not for me to describe the system, or the details of its construction and working, in the presence of its inventor and designer. But, if I may be allowed, I would just point out its leading features, and compare it with the systems dealt with.

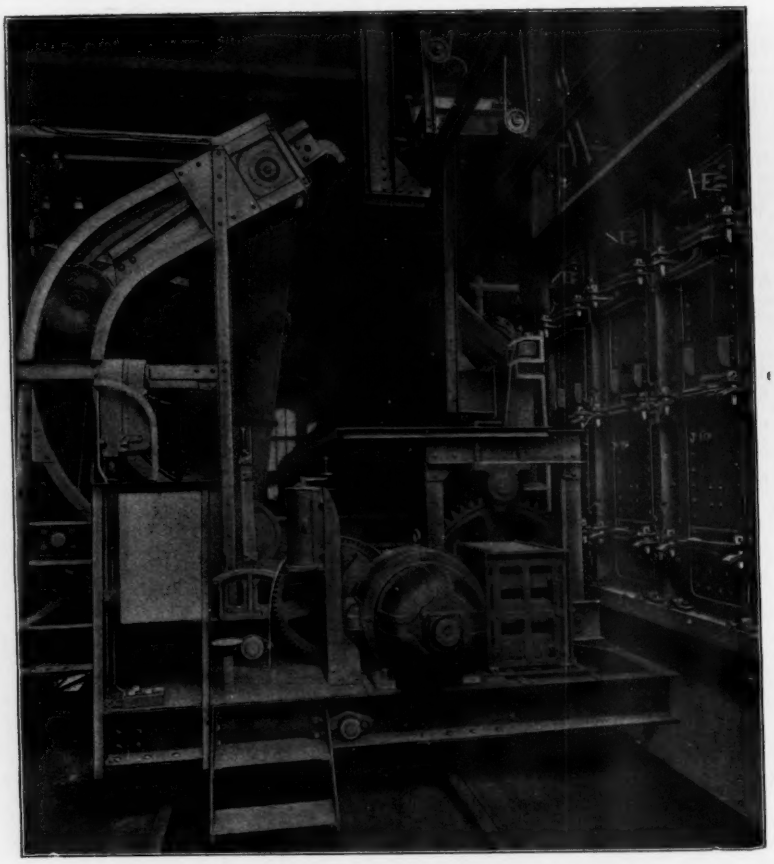
Mr. Thomas Glover has succeeded in obtaining a fairly



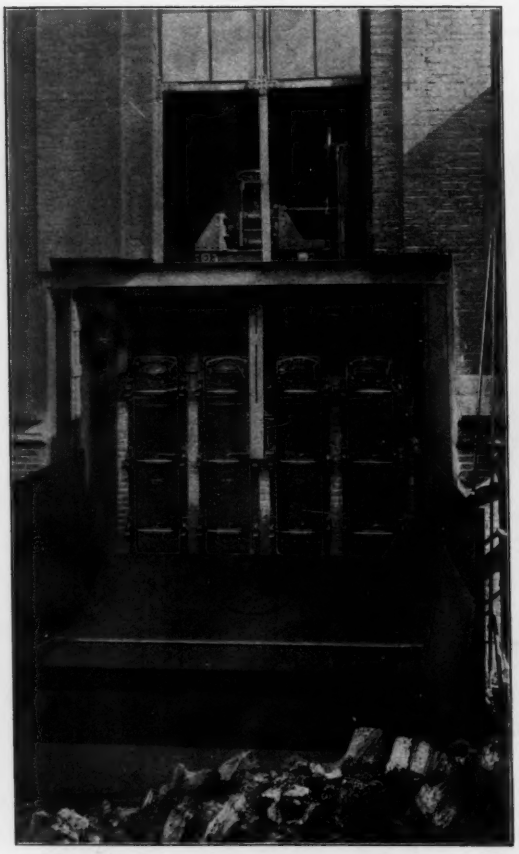
The Inclined Carbonizing Chambers at Konigsberg.



Two Settings of Four Inclined Carbonizing Chambers at Konigsberg.

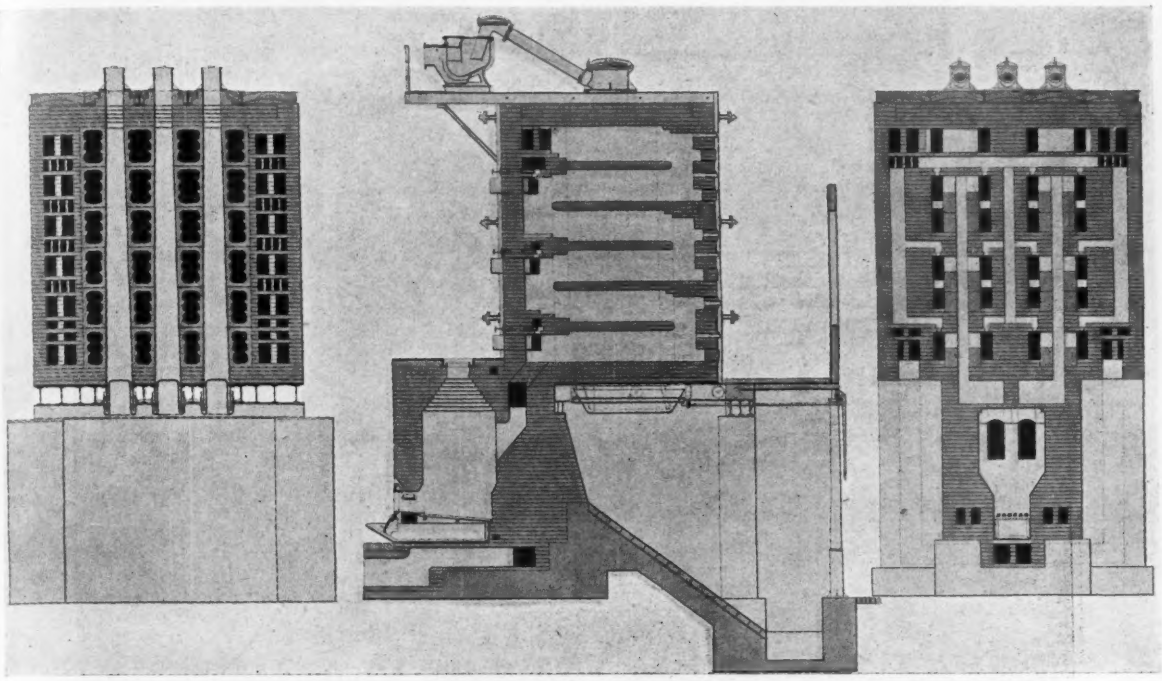


Coke Discharger with Electric Motor at the Back of the Klonne Setting at Rotterdam.



Front of the Klonne Chamber Setting at Rotterdam, with the Apparatus for Raising and Taking Away the Doors of the Chambers.

Side View of the Klonne Chamber Setting at Rotterdam, showing the Ascension-Pipes, Hydraulic Main, Charging Funnels, &c.



The Horn Patent Vertical Chamber-Oven.

heavy charge of 1 ton, at the same time not foregoing the general arrangement of the retort-furnace and certain of its undoubted advantages. The resulting chamber-retort* is a happy medium between the large-space chamber and the ordinary retort, and a consequent compromise between the principal characteristics of the two—notably a combination of large make of gas with a candle power more amenable to English taste than that acceptable to Continental ambitions. In regard to the labour involved, the system seems to stand midway between the retort of up-to-date equipment and the large chambers. On the other hand, an undoubted advantage of the system—more especially in connection with the smaller works—seems to be its more general applicability to existing plant, as probably any suitable retort-setting can be adapted to it without removing the main structure.

There is one other design of British origin which certainly deserves to be mentioned in this connection. This is a vertical chamber designed by Mr. A. O. Jones, of which an experimental setting is erected in Staffordshire. It is primarily designed as a coke oven, and consequently gas heated; but the intention is to adapt it to gas-works purposes, if results on the large scale should prove at all satisfactory. I have had an opportunity of closely studying this plant, and must confess I was equally struck by the boldness of design, the successful execution, and the smoothness of the running. This vertical chamber takes a charge of 6·5 to 7 tons of coal. It is evenly heated by horizontal flues with independent gas and air supply, which seem to be almost ideal in their accessibility. It is charged from a travelling hopper, the charging occupying only 20 seconds. The difficulty of designing the bottom door which has to stand the pressure of the charge, and yet keep gas-tight, has been successfully overcome; the door being of the sliding type, and the power to withdraw it from under the charge being very moderate indeed. As yet, no definite data as regards the make of quality of the gas are to hand; but the character of the bye-products—notably the tar—justifies the expectation of a close analogy with the results in vertical retorts.

Advantages and Disadvantages.

If we now turn to the consideration of the available data as regards carbonization in chambers generally, we may compare the advantages claimed for the system, and no doubt largely attained, in the following terms:—

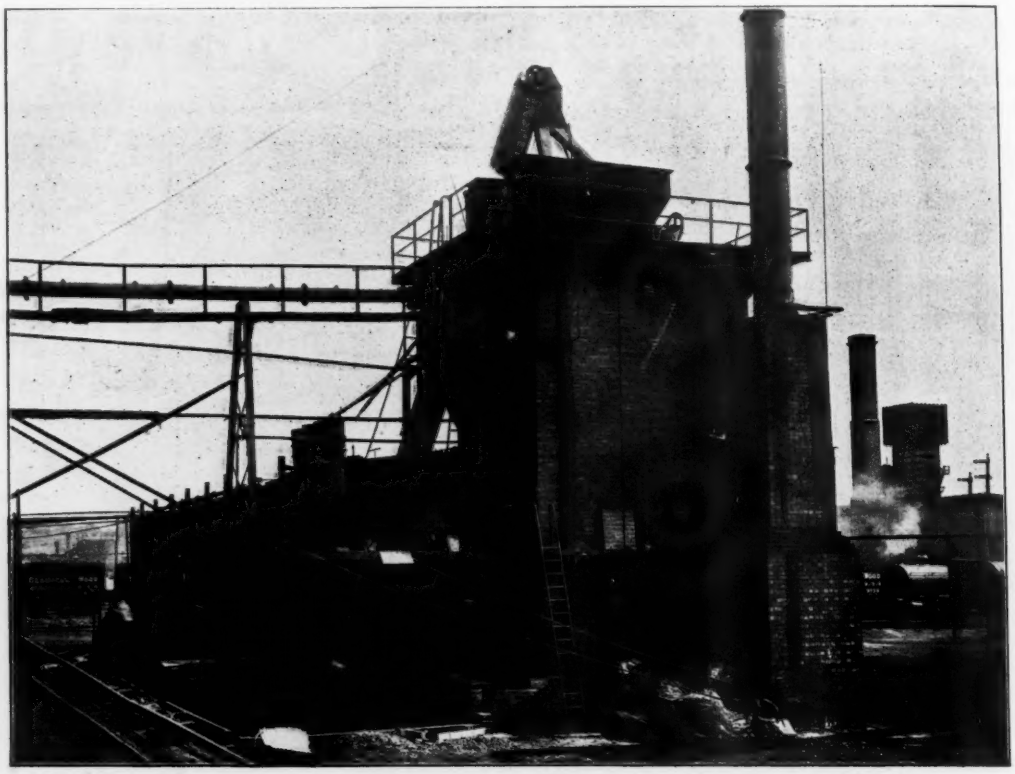
Long-period charges permit a great saving in labour, and consequent reduction of carbonizing cost, particularly in the case of 24-hour charges, where no night work is required except for tending the producer fires and watching the process.

High make of gas, due to limited secondary decomposition; therefore, good calorific value.

Little carbon deposit; scurfing to be done easily and conveniently. Ascension pipes keep clear.

A. O. Jones' Vertical Coke-Oven.

* Illustrations of the arrangement here referred to appeared in last week's "Journal," p. 700-01.



A. O. Jones' Vertical Coke-Oven.

Small consumption of fuel, and little loss through radiation.

Coke of very good quality and size.

Tar thin, and containing little free carbon.

Smaller heated surface per ton of coal carbonized than in retorts, and less chance for decomposition and infiltration of flue gases.

Large yield of gas on small area covered.

Manipulation is simple and comfortable for the men.

The life of the plant should be considerably longer than that of ordinary retort plant.

Against this stand as disadvantages:—

Low illuminating power. This, of course, is in this country, and in view of parliamentary obligations, an all-important factor.

High cost of installation, which, however, can soon be made good by greater economy in working and smaller capital charges on account of higher durability.

Theoretical Aspects of Carbonization in Bulk.

The question of the illuminating power of the gas made in chambers of great capacity gives rise to some theoretical considerations. In an ordinary gas-retort, with a small charge in a comparatively thin layer, the manifold changes which a lump of coal has to undergo during the carbonizing process are confined within a small space and a short period of time. The consequence is that they are, as regards space and time, overlapping each other to a large extent, with the very desirable result of a fairly uniform quality from start to finish. In the chamber, on the other hand, it is only natural that these changes should occur in chronological sequence, and should proceed from one part to another, so that at any given moment the occurrences in different parts of the heavy charge would be different from each other, and the reactions proceeding on a given spot would vary from those taking place on the same spot at a different period of the process. While these conditions do not exactly favour the uniformity of the gas produced, they afford to the student of carbonization a splendid opportunity for investigating the process, dissected as it would be locally and by time in various and distinct stages.

With regard to most characteristics of the gas, these variations are really not as wide as to seriously upset the equilibrium of uniformity. Make of gas, calorific value, and specific gravity, show—on reference to Professor Bunte's diagram—appreciable discrepancies from the average values only during a few hours at the beginning and end of the 24-hour charge. This fact, I believe, must be put down to the probability of the heavy charge acting, so to speak, as a fly-wheel, resisting the disturbing influences by its own inertia, and compensating the results of temporal and local influences. Professor Bunte's results were obtained with charges of only 3·2 tons per chamber. I should not be surprised to learn that, on repeating the experiments with the latest plant, the doubling of the charges would prove very beneficial in this respect.

The only curve which shows very serious variations is that representing the illuminating power of the gas made at different periods of the experiment. During the first 40 minutes, it rises to above 30 candles; then it soon drops, until it comes down to the average of about 11 candles; keeps this up throughout the first half of carbonization; and then gently and steadily falls to the level of non-luminosity at the end of the 24th hour. An explanation of this may be the following.

The Process of Carbonization.

Carbonization sets in at the walls of the chamber. The drying, the softening, and the decomposition of the layers of coal in the immediate proximity of the walls proceeds very rapidly, and with a very short (if any) time interval between these stages; they running practically in parallel. Hence the peculiar, cauliflower-like appearance of the outside layers of coke from ovens or chambers, quite distinct from the inner part. During these initial stages, the bulk of the coal is still cool, and retains its physical structure, thus allowing the gas made by the destructive distillation of the outer surface to pass freely through its entire mass. It is thereby, naturally, loaded with those hydrocarbons which have been released from their molecular bondage by the geological coking process in the coal seam, and are readily given off at ordinary or comparatively low temperatures upon the passage of a gas current. This period, I presume, is identical with the rising branch of the curve, indicating a very high illuminating power. Besides, the great mass of coal must, by means of its low specific heat, exercise a cooling effect on the chamber walls for a considerable length of time. The rich hydrocarbons therefore are passing undecomposed along the roof of the chamber.

As soon as the heat has sufficiently penetrated the outer layers to be able to soften the undecomposed coal, the conditions would be considerably altered. The coal, where it has become plastic, forms a zone which is, to a certain extent, impenetrable or semi-permeable to the gas, or at least offers an appreciable resistance to its passage through the

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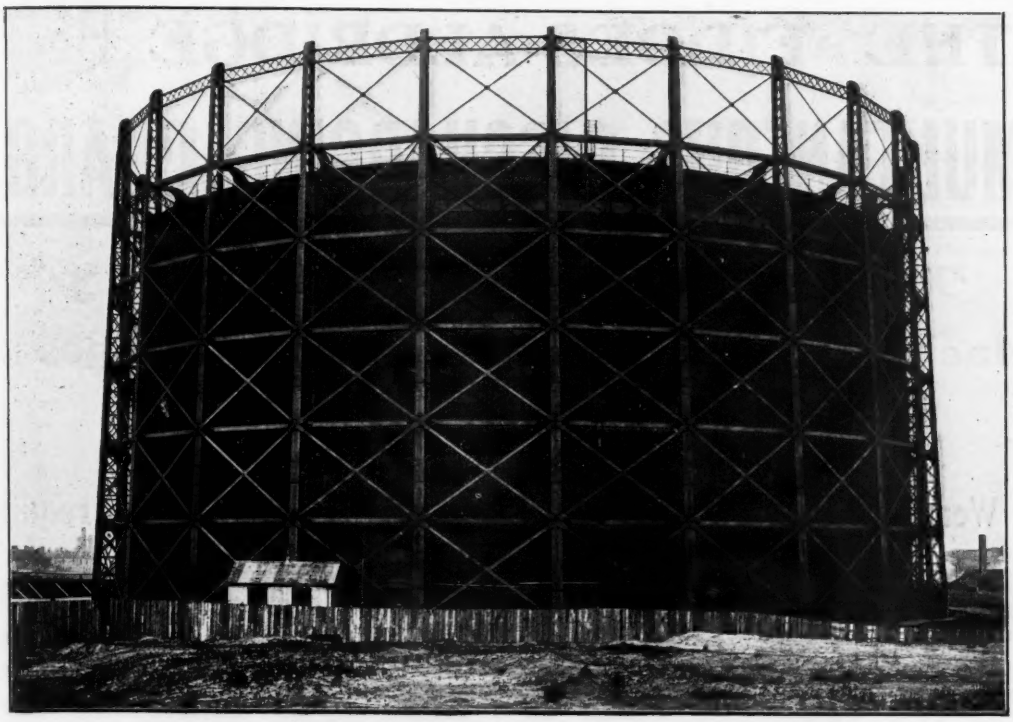

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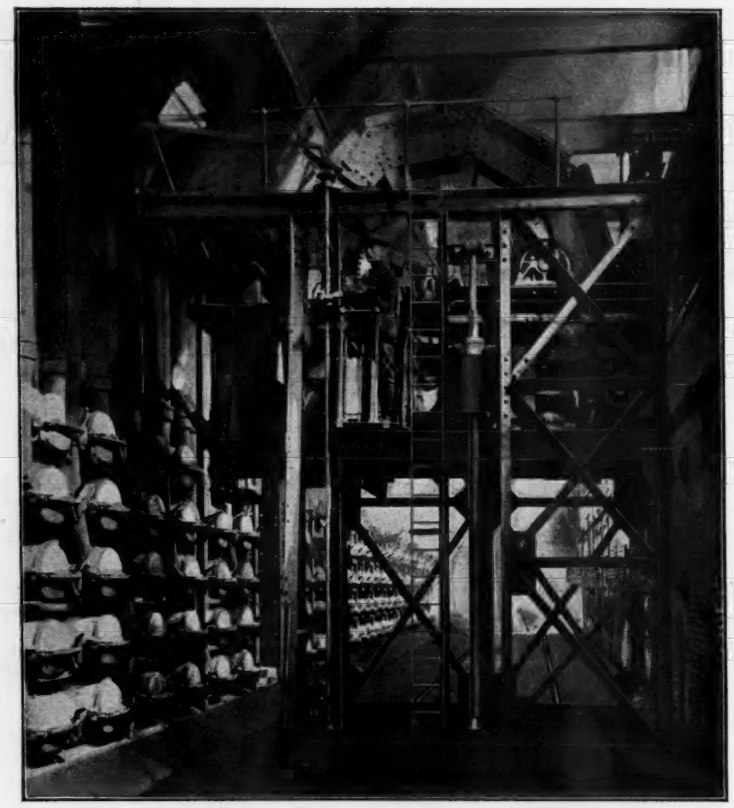

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entire mass. Consequently, the gas would now be forced to find a convenient passage through the outer layers (which by this time would be coked to an increasing extent) and along the walls to the crown of the chamber. By contact with the hot coke, and by the surface and radiant heat of the walls, it would suffer a degradation, with incidental deposition of carbon. This finds outer expression in the rapidly descending branch of the illuminating power curve.

This theory finds, I believe, a certain support in two observations. It is a common experience, and well known to every coke-oven man, that the cake of coke stands off the side of the chamber at a distance of sometimes upwards of 1 inch. Further, it is split in the centre by a vertical plane along its longitudinal axis, which allows the cake, after removal from the coking chamber, to fall in halves to either side. This phenomenon is so marked that, even with inclined chambers, the two halves may be observed separating while coming down the slope.

The meaning of the first observation is, I think, that the coal, while softening, has a tendency to consolidation by filling the intervening spaces, and is assisted herein by the condensation of the heavier hydrocarbons. The slight pressure put on the gas by the resistance of this zone may be sufficient to influence this tendency in the direction towards the centre, making room for the escape of the gas along the chamber wall.

How little pressure is required for an action of this type may again be gathered from a parallel in coke-oven practice. To allow a coke charge to glide readily across the quenching platform, it is customary to turn the water-hose on the latter before discharging an oven. It is, no doubt, the steam cushion formed which brings about this "lubrication," by exercising a lifting effect on the mass of coke, which, though almost insignificant in itself, is by its momentary action sufficient to serve the purpose.

If this assumption is correct, it stands to reason that the gas pressure during the period of plasticity or semi-permeability of the coal may suffice to push the charge away from the wall. During this period, the gas current coming from the interior would have a great velocity, and consequently not be subject to considerable decomposition on its course along the heated walls, which explains its fair illuminating power.

While the softening is proceeding towards the centre, the destructive distillation follows suit; the less volatile hydrocarbons being condensed and taken up by the plastic coal, practically dissolving it. Receding from both sides, these layers of coal solution in pitch meet finally in the centre, forming a very soft mass indeed. This layer yields to the influence of heat; its volatilization being more akin to tar distillation than to the destructive carbonization of original coal. The rather brittle tar coke which is left behind, and which has none of the characteristic features of either the compact principal product or of the rapidly formed external part, allows the two halves to be easily separated; and its formation can explain the second observation referred to.

I hope I shall not be accused of transgressing the permissible limits of imagination, if I suggest that in the small maximum at the eleventh hour of the illuminating power curve, we recognize the distillation of this tarry product. As soon as it is permeable enough for gas to bubble through, the distillation of the more pitchy part left or produced in the coal begins. The gas now formed finds a free passage wherever it goes; and by reason of its now decreased velocity, and the larger and hotter surface it has to pass, suffers decomposition which must be correlated to the descending branch of the curve.

Conclusion.

Having considered the practical possibilities and the theoretical aspects of carbonization in bulk, I venture to hope that sufficient interest attaches to this problem to justify my claims upon your patience and indulgence. I have not brought this subject before you to advocate its ready acceptance in preference to any other system of carbonization, but rather to chronicle events and stimulate enterprise and progress by showing its remarkably rapid development. This system is by no means perfect. It is only in its infancy, and has not even gone through its infantile diseases. Many improvements will have to be effected to bring it anywhere near perfection; but just this lack of perfection opens a promising field for the activity of gas engineers.

So far no plant of large dimensions has been erected in this country, though rumour has it that there will be some chamber-settings before long. No doubt the defective illuminating power of the gas to be obtained is partly responsible for this. Great difficulties have to be overcome in this respect. Perhaps it is left to the world-renowned mechanical skill of the British engineer to devise means for the application to the chamber system of the continuous principle which has found such favour in connection with retorts in this country. A device of such a description should prove exceedingly useful as a gas, coke, and bye-product making machine; and the realization of this pious wish would possibly permit the gas industry to again rest on its laurels for many years to come.

REPORT OF THE CARBONIZING COMMITTEE.

The Carbonizing Committee have much pleasure in presenting a report which has been prepared by Dr. R. Lessing, at their request and under their direction, showing the progress which has been made in carbonizing processes in this and other countries during the last twelve months, from which it will be seen that the year has been remarkable for the enormous development of the vertical retort and the carbonizing chamber systems on the Continent.

The outstanding developments in this country during the year include the commencement of an installation of Dessau vertical retorts at Sunderland, and one of the Woodall and Duckham vertical retorts on the continuous system at Burnley; also the starting of the Young and Glover vertical retorts at St. Helens.

Another distinct feature is the increasing use of heavier charges and longer periods in the working of horizontal retorts. The great improvements effected by this method of working are clearly set forth in the paper to be presented by Mr. J. Ferguson Bell, of Derby.

(Signed) Thomas Glover.
Charles Carpenter.
Arthur E. Broadberry.
Sydney Y. Shoubridge.

Southampton House, No. 317, High Holborn, W.C., June 10, 1909.

To the Carbonizing Committee, Institution of Gas Engineers.

Gentlemen,—In accordance with the instructions received from your Committee on the 24th ult., I have pleasure in submitting to you the following report on the progress in the methods of carbonization during last year. In doing so, I have to ask your indulgence with regard to the shortcomings of this document; the time available having been very limited for the collection and the compilation of the necessary data. The report can therefore, at best, be regarded as of a preliminary nature only; but I should be pleased to supplement it in its details if that be desired.

After a hundred years of steady, and consequently rather slow, progress by methods of evolution, the gas industry has entered a new era. The commencement of the second century of its existence has been heralded in by some revolutionary changes, more especially as regards the methods of gas production. Developments have, during the last five years or so, assumed so rapid a pace, and are of so varied a character, that it renders the task of picturing the state of advance at any given moment an extremely difficult and delicate one. New principles are proposed, tried, tested, and applied in rapid succession, only to be equalled, replaced, or overtaken by the results of competitive methods within the shortest periods of time.

In reviewing the progress made, it therefore seems the most feasible course to take each system of carbonization by itself, and inquire into the advances it has made during the time under investigation.

Vertical Retorts.

Dessau Intermittent System.—This system deserves mention in the first place on account of its having, up to now, enjoyed more success than any of its competitors. As will be seen from the accompanying list of installations,* its rapid progress seems to continue unabated. When, on the occasion of last year's visit of the Institution of Gas Engineers, the Dessau retort was seen in operation for the first time by a large number of British engineers, it had already been installed in a great number of gas-works. Through the activity of its patentees and promoters, and enjoying

* See Appendix I., p. 844.

the technical, financial, and moral support of a powerful group of industrialists, it has further gained in favour, and been adopted in a progressively increasing number of works. It is significant that, out of about 4022 retorts erected or under construction, more than 1000 were to the order of one individual company.

As to the working results of the Dessau system, there is nothing to add to the reports submitted through your Committee at last year's meeting by Messrs. A. E. Broadberry and H. G. Colman, and the exhaustive investigation of Professor Bunte's Testing Institution carried out at the same time at Berlin-Mariendorf and Zurich-Schlieren, which practically confirmed the statements made previously on various occasions by the authorities of the Dessau Vertical Retort Company. A statement recently issued by Mr. Edward Körting, together with reports by Messrs. Prenger and Weiss, indicate a durability of the Dessau retort of 900 to 1000, or even more, firing-days, after which probably only the lower parts of the retorts will have to be renewed.

As to the technical advance made in connection with the Dessau retort, there is little to be recorded—a fact which should not cause surprise in view of the extremely careful working out of all details before putting it on the market.

The question of water-gas production in the retort received a good deal of attention during the last twelve months. Mr. E. Körting, to whom the success of the Dessau retort is largely due, and Dr. Geipert, claim several advantages for the "wet carbonization"—*i.e.*, admission of steam into the retort, while Messrs. Kobbert, Strache, Terhaerst, and Trautwein regard the production of water gas in separate plant, and its subsequent admixture to the coal gas, as a more advantageous course to follow.

Dessau plants have been erected outside Germany—in Spain, Switzerland, Italy, Austria, South America, and the United States. In this country there is only one plant, comprising six beds of ten retorts each, which is in course of construction by the Sunderland Gas Company, and is expected to be in operation in September next.

Other Systems of Vertical Retorts.—A number of patents have been applied for in connection with vertical retorts; but as no information as to their erection has come to hand, they need not be dealt with here.

Two beds of vertical retorts have been in operation for a short time at the gas-works at Étaples, in France. They were built to the designs of M. Derval; but no details of construction or working results are as yet available.

Vertical Retorts in Great Britain.

From the higher building record which the German pattern of vertical retort has attained, it must by no means be inferred that sufficient attention has not been paid to the problem in this country. One of the causes of the slower progress is rather to be sought in the more ambitious task that English engineers have set themselves by making the continuity of feed and discharge a principal feature of their various designs. Considering all the factors involved, and in view of the wider experience gained, it must be admitted that this principle is not only a perfectly sound one, but appears to be preferable to that of an intermittently charged and completely discharged retort, both from theoretical and economic considerations.

Woodall-Duckham System.—Considerable progress has been made with this system; and it may be said that it has overcome most of the initial difficulties. There is now working a setting of four retorts at the Nine Elms works of the Gaslight and Coke Company; a bench of ten settings, of four retorts each, is being constructed at the Kensal Green station of the same Company; and nine settings, of four retorts each, are nearly completed at the works of the Burnley Corporation.

By the kind permission of Mr. Thomas Goulden, the Chief Engineer of the Gaslight and Coke Company, the following results obtained in a recent test of 6½ days' duration with the Nine Elms plant may be given:

Total gas made	787,175 cubic feet.
,, coal used	61·39 tons.
Gas made per 24 hours per four retorts	124,290 cubic feet.
Gas made per ton	12,839 cubic feet.
Candle power	15·2 (No. 2 "Metropolitan" burner).
B.Th.U. gross	571
,, net	509·7

An installation of these retorts is being erected in America at the Grange, in the neighbourhood of Chicago, in order to test the local coal. Should the trial prove successful, a very considerable plant will be put down in the same place.

In France, one setting is at work at Lyons; three more being contemplated at these works.

Young and Glover System.—This system has only within the period of review really assumed practical shape. A setting of eight retorts, 20 feet in length, was erected at the St. Helens Corporation Gas-Works by West's Gas Improvement Company, Limited; and operations on it commenced about seven months ago. After various trials and slight alterations, the plant has recently been repeatedly tested by independent experts with most satisfactory results. Special condensing, scrubbing, purifying, and measuring plant being provided, the results can be absolutely determined. So far, local (Lancashire) coals only have been carbonized; and these being of rather inferior quality, the results should be improved upon when carbonizing good gas coal. From these, about 11,500 to 11,800 cubic feet of gas were made per ton of coal of an illuminating power of about 16 candles tested by the "Metropolitan" No. 2 burner, and of a net calorific value of 530 to 540 B.Th.U.

The gas was of a very satisfactory composition, showing not more than 3 per cent. of nitrogen. The yield of dry coke was 14·2 cwt. per ton, of very superior quality, and the fuel consumed amounted only to 12·06 per cent. of dry coke. Of bye-products, about 33·5 lbs. of sulphate of ammonia were produced per ton of coal carbonized, and 16 gallons of tar of a very satisfactory composition.

The good results obtained seem to be largely due—quite apart from the continuous principle involved—to the very excellent heating arrangements in horizontal compartments, which permit of a convenient and independent adjustment of the temperature at every height of the retort. The uniformity of the gas, of course, is largely safeguarded by the continuity of feed to the retort. The mechanical appliances—notably, the coke discharging arrangement—have so far worked very smoothly.

Other Systems of Vertical Retorts.—Mr. W. R. Herring is at present erecting a setting of vertical retorts at the Edinburgh Gas-Works, for which a capacity of 30 tons of coal per day is anticipated. This will be distinguished from all other existing types by being so arranged as to allow of continuous or intermittent carbonizing. In its construction, the lines so successfully adopted in the shale oil-works in Scotland were closely followed, and satisfactory results are expected. It is hoped to have the plant at work during next winter.

Mr. Alexander Wilson is also experimenting with vertical retorts at Glasgow; but no definite results are so far available.

An installation of vertical retorts has been built at the Cleethorpes Gas-Works by Messrs. R. Dempster and Sons, Limited, which is at present under test, and of which particulars are expected shortly.

In this connection, mention may be made of the trials carried out by the late Mr. Love, at the Guildford Gas-Works, with a setting of eight inclined retorts set at an angle of 45°. Their working seems to be largely analogous to that of vertical retorts. Settings of this type have been erected at Market Harborough, Swindon, and in Wales; but no new results have come to hand.

Chamber Settings.

Although the birthday of the chamber system of carbonization lies back several years, its more general adoption and the erection of the existing installations come within the period here under review. Moreover, I have no hesitation in saying that I consider the coming of the chamber settings by far the most important event in the carbonizing branch of the gas industry during the past twelve months.

As I shall have the honour of bringing this subject before the members of the Institution of Gas Engineers at the forthcoming annual meeting, it may perhaps be advisable not to go into details of construction and working here, but confine myself to the statistical and economic aspect of the problem, and the more so as these considerations form, at the present moment, the only reliable evidence for a discussion of the merits of the system.

A year ago, only one plant of this class was at work at Munich—erected by the original designer and patentee, Herr H. Ries. This installation, which is still at work, consists of a bench of five settings of three chambers each, and has a carbonizing capacity of 48 tons per twenty-four hours. A good deal of attention was and is being paid

to the problem of carbonization in large bulk, notably in Germany; and there are now plants of quite a number of makers and of various designs on the market.

The rapidity of expansion of the system may be gathered from the fact that to-day there are eleven installations at work, with a daily carbonizing capacity of about 640 tons of coal; and chambers of various systems, of an aggregate carbonizing capacity of over 2000 tons, are in course of construction. Most of these are expected to commence working before the end of this year.

Particulars, as far as these are available, in respect of these plants are compiled in the accompanying table (Appendices II. and IIA.); but with regard to the results given, the very short period of operation must be borne in mind. It will be gathered from the table that the results of all systems seem to be of approximately the same character—viz., a make of gas of about 12,000 cubic feet per ton of coal carbonized, of a net calorific value of about 550 B.Th.U. The coke yield would be somewhere near 15 cwt. per ton, and its quality practically equal, or not much inferior, to metallurgical coke. With a fair yield of ammonia is combined the production of a light tar, containing very little free carbon.

Most of the works which have adopted chamber settings are situated in Germany, with two in Austria, one in Holland, one in France, and two in Italy. The majority of these chambers are inclined, as in the original Munich type; but horizontal and vertical chambers are also being built.

The advantages and disadvantages of the chamber system, I have discussed in my paper. It may therefore suffice to mention here that the system seems to yield all the advantages which, it is now generally accepted, attach to the carbonization of heavy charges. Against these stand the drawbacks of a comparatively low illuminating power and a rather higher initial capital outlay, although this latter point is compensated to a certain extent by the economies of working and the longer durability expected.

In this country, Mr. Thomas Glover, of Norwich, the President of the Institution, has patented and erected a plant which is intended to combine the advantages of the horizontal retort with that of the large-space chamber. His chamber retort is capable of carbonizing about 21 cwt. of coal in twelve hours. The yield is about 12,300 cubic feet per ton of Yorkshire small coal, of a gas of about 15 candles and 500 B.Th.U. net. The coke produced is much superior to ordinary gas coke; and the yield of bye-products is quite satisfactory. The chambers are charged by a "De Brouwer" projector and discharged by a "Jenkins De Brouwer" ram. If these results are maintained in extended working, the system has much to recommend it, more especially for the smaller and medium-sized works.

Experiments with inclined chambers of a capacity varying from 15 to 25 cwt. per chamber are being carried out by Mr. Johnston at the Brentford Gas-Works. Considerable interest should attach to the outcome of these trials, as attempts are made to guide the travel of the gas through the charge in a direction most conducive to obtaining a high quality, by providing a vertical partition wall, which, by means of suitable recesses, collects the gas in the centre of the charge.

Horizontal and Inclined Retorts.

To characterize the feeling on the Continent with regard to the ordinary types of carbonizing plant, I think I cannot do better than quote from the replies of two of the leading German firms to independent inquiries submitted to them. One firm writes:

> **The systems of horizontal retorts with charging and drawing machines and of inclined retorts have been overtaken by the systems of vertical retorts and chamber settings to such an extent that we should like to refrain from communicating any results relating to the former.**

The other observation is as follows:—

> **Besides these large type chamber settings, I have been adapting same to smaller gas-works, and am building one for trial to be worked and served by hand (to the order of a German gas works) which will be under fire shortly. Should this latter type prove successful, then there is no doubt that in this country at any rate, retort-furnaces have seen their best days.**

To fully appreciate the serious meaning of these remarks—made absolutely independent of each other—it might be well to state that both firms are makers of ordinary retort plants in a large way, both having a great number of specialities of patented devices, and should be expected to be pushing along the lines in which their organization has proved successful.

It may be added that in Germany mechanical manipulation of horizontal retorts has never found as much favour as in this country. During the last few years, previous to the introduction of verticals and chambers, the more important works had been adopting inclined retorts when re-erecting or extending plant.

Progress in Great Britain.—The position in this country with regard to what I may term ordinary plant is a rather different one. For various reasons the most recent systems of carbonization have not been adopted to a considerable extent by English gas-works. On the other hand, engineers have found ways and means to very much improve their methods, and to lessen the cost of production.

The more clumsy types of charging and drawing machines for horizontals have given way to very efficient machines of high capacity. The tendency seems to be to combine both operations in one stroke; and as a very successful specimen of this type, the Fiddes-Aldridge machine deserves mention. The cost of carbonizing has been reduced by the employment of this machine to 8d. (from coal into breaker to coke outside retort-house) at the Linacre works of the Liverpool Gas Company, and to 7½d. (at Metropolitan rate of wages) at one of the stations of the Gaslight and Coke Company. During 1908, eight, and during the first months of 1909, fourteen, of these machines have been installed or are building, out of a total of 28 so far supplied.

Messrs. West have also under construction for the Aarhus Gas-Works in Denmark a simultaneous charging and discharging machine electrically driven.

The De Brouwer projector has been adapted by Messrs. W. J. Jenkins and Co., of Retford, to the charging of coke-ovens and chamber retorts.

The development of the mechanical manipulation of horizontal retorts is the more important, as there is an undoubted tendency in various quarters to work these with heavier charges and less vacant space between the coal and the crown of the retort.

This tendency—most likely influenced by the experience with fully-charged vertical retorts—is very remarkable, and yields, in practice, interesting and useful results. Though the movement has not yet become general, it is likely to gain ground as the reduction in illuminating power goes on.

A set of very exhaustive investigations which Mr. J. Ferguson Bell has carried out at the Derby Gas-Works in regard to heavy charges in horizontal retorts will be communicated at the forthcoming meeting of the Institution.

Low Temperature Carbonization.—During last year, a plant of two benches has been erected on the premises of the Plymouth and Stonehouse Gas Company to work the "Coalite" process; and a third bench is being built. Each bench consists of 32 castings of twelve tubes; each casting taking a charge of 6 cwt. of coal, or ½ cwt. in each tube. The plant has been in operation since the middle of February. At a recent test with Barnsley coal, 4951 cubic feet of gas were made per ton, having an illuminating value of 20·3 candles in the jet photometer. The bye-products produced are about 22 gallons of tar rich in light oils, 15 lbs. of ammonium sulphate, and 12 cwt. of "Coalite" per ton.

The introduction of retort-house governors makes steady progress; their value in maintaining the uniform pressure inside the retort, and consequently favouring the production of a more uniform gas, being highly appreciated.

One factor which must not be lost sight of when considering economic advances is the successful introduction of up-to-date coal and coke conveying plant, which is to a very large extent responsible for reductions effected in carbonizing costs.

In considering the progress in different countries, I regret to be almost exclusively confined to what has been done in Great Britain and Germany. Several French firms who were approached seem to feel rather reluctant in furnishing information. It was not deemed necessary to gather information from other European countries; most of their plants being of either British or German origin or design.

For the collection of material from the other side of the Atlantic, I was unfortunately prevented through lack of available time.

I have in these lines confined myself to the practical aspects of carbonization. But I think it only right to draw attention to the studies in coal carbonizing by Mr. R. Forbes Carpenter, to which another excellent piece of research has been added in this year's "Alkali Report," which has been published during the passage through the

press of this report. The investigation of the ammonia and hydrocyanic acid equilibrium in the gas-retort should prove of great value during the present state of transition of our conception of carbonization of coal; while the surprising formation of cyanogen at low temperatures observed in practice, and apparently incompatible with theoretical conclusions, should give rise to some further highly interesting researches.

I beg to remain, &c.,

(Signed) R. LESSING.

APPENDIX I.—PLACES WHERE THE DESSAU VERTICAL RETORT SYSTEM HAS BEEN ADOPTED.

1906 (and before).

Barcelona	15 settings, with	150	retorts
Cologne	24 ,, ,,	240	,,
Dessau	6 ,, ,,	60	,,
Potsdam	4 ,, ,,	48	,,
Brandenburg	6 ,, ,,	60	,,
Duisburg	5 ,, ,,	50	,,
Aschaffenburg	1 ,, ,,	8	,,
Zürich	10 ,, ,,	100	,,
Dortmund	10 ,, ,,	100	,,
Ludwigshafen	3 ,, ,,	30	,,
	84 settings, with	846	retorts

1907.

Berlin—Oberspree	4 settings, with	48	retorts
,, Mariendorf	7 ,, ,,	84	,,
,, ,,	7 ,, ,,	84	,,
,, Tegel	1 ,, ,,	10	,,
Dusseldorf	7 ,, ,,	70	,,
Solingen	3 ,, ,,	30	,,
Halle	6 ,, ,,	60	,,
Elberfeld	12 ,, ,,	120	,,
Hamburg—Grasbrook	5 ,, ,,	50	,,
Magdeburg	8 ,, ,,	80	,,
Frankfort—Bockenheim	12 ,, ,,	120	,,
Offenbach	8 ,, ,,	80	,,
Trieste	1 ,, ,,	20	,,
Genoa	6 ,, ,,	60	,,
	87 settings, with	916	retorts

1908.

City of Berlin—Danzigerstr.	24 settings, with	240	retorts
,, ,, Schmargendorf	8 ,, ,,	80	,,
Berlin—Weissensee	5 ,, ,,	58	,,
,, Mariendorf	7 ,, ,,	84	,,
,, ,,	7 ,, ,,	84	,,
,, Holzmarktstrasse	4 ,, ,,	40	,,
Chemnitz	6 ,, ,,	60	,,
Potsdam	4 ,, ,,	40	,,
Worms	3 ,, ,,	30	,,
Charlottenburg	7 ,, ,,	70	,,
Rio de Janeiro	14 ,, ,,	140	,,
Sunderland	6 ,, ,,	60	,,
Brussels—Forest	12 ,, ,,	120	,,
Warsaw	10 ,, ,,	120	,,
Munich—Gladbach	5 ,, ,,	50	,,
Bremen	16 ,, ,,	160	,,
Aix-la-Chapelle	20 ,, ,,	200	,,
	158 settings, with	1636	retorts

1909 (to date).

Osnabruck	5 settings, with	50	retorts
Helsingfors	8 ,, ,,	80	,,
Freiburg	5 ,, ,,	50	,,
Schott and Cen., Jena	2 ,, ,,	16	,,
Barcelona	10 ,, ,,	100	,,
,,	5 ,, ,,	50	,,
Offenbach	4 ,, ,,	40	,,
Berne	8 ,, ,,	80	,,
Aschaffenburg	1 ,, ,,	8	,,
Bahia	3 ,, ,,	30	,,
Providence (U.S.A.)	12 ,, ,,	120	,,
	63 settings, with	624	retorts

Total 392 settings with 4022 retorts.

APPENDIX II.—CHAMBER SETTINGS IN OPERATION.

At	System.	Type.	Number of Settings.	Number of Chambers.	Charge per Chamber in Tons.	Period of Carbonization in Hours.	Capacity of Plant per 24 Hours in Tons.	Cubic Feet Gas Made per Ton.	Net Calorific Value B.Th.U.	Date when Started.
Munich-Kirchstein	Ries	Inclined	5	15	3·2	24	48·5	10,950	600	Oct. 6, 1906
Munich-Moosach	,,	,,	6	18	6·5	24	116·4	—	—	Apr. 23, 1909
Hamburg-Grasbrook	,,	,,	10	30	5·8	24	175·0	12,500	—	June 1, 1908
Bochum	Koppers	,,	—	7	8·0	24	56·0	11,300	550	Sept. 1, 1908
Vienna	,,	,,	—	15	8·0	24	120·0	11,300	550	Dec. 30, 1908
Halberstadt	Knoch	,,	—	—	—	—	—	—	—	April, 1908
Boehlitz	,,	,,	—	9	3·4	24	30·6	11,700	—	Recently
Königsberg	Klönne	,,	2	8	7·2	24	57·6	11,700	550	Beginning 1909
Rotterdam	,,	Horizontal	1	4	2·7	24	10·9	12,000	560	Aug. 9, 1908
Dortmund	,,	Vertical	1	5	1·3	12	15·0	12,000	—	Recently
Hecklingen	Horn	,,	—	—	—	—	12·5	—	—	,,

APPENDIX IIA.—CHAMBER SETTINGS UNDER CONSTRUCTION.

At	System.	Type.	Number of Settings.	Number of Chambers.	Charge per Chamber in Tons.	Capacity of Plant per 24 Hours in Tons.	
Leipzic	Ries	Inclined	8	24	6·5	155·2	ready to start
Paris	,,	,,	20	60	4·5	272·0	
Rome	,,	,,	20	60	5·8	350·0	
Berlin-Tegel	,,	,,	27	71	6·5	523·8	
Hanau	,,	,,	8	24	4·5	108·8	
Regensburg	,,	,,	5	15	4·5	68·0	
,,	,,	,,	2	6	2·7	16·0	
Munich-Moosach	,,	,,	6	18	6·5	116·4	
Vienna	Koppers	,,	—	19	8·0	152·0	
Halberstadt	,,	,,	—	9	8·0	72·0	
Innsbruck	,,	,,	—	12	8·0	96·0	
Zwickau	Klönne	,,	2	8	—	—	
Königsberg	,,	,,	4	16	7·2	115·0	
Rixdorf	,,	Horizontal	—	—	—	—	
Frankenthal	,,	,,	—	—	—	—	
Padua	,,	,,	—	—	—	—	

CARBONIZING.

By J. FERGUSON BELL, M.Inst.C.E., of Derby.

The subject of carbonizing has become during the last few years one of peculiar interest, on account of the recent developments in plant for the distillation of coal in the production of town gas, and incidentally of the bye-products which result, and which are of such importance to the industry, both in an economic and technical sense.

The purpose of this paper is to describe the carbonizing plant erected last year at the Litchurch works of the Derby Gaslight and Coke Company, and to give the working costs, and also mainly the carbonizing results obtained with experimental charges of from six to twelve hours' duration over the past few months.

DESCRIPTION OF PLANT.

The walls of No. 2 retort-house were raised some 17 feet, to convert the house from a ground-floor into a stage-floor one, in preference to excavating to form a cellar for the furnaces. The old retort-bench was taken down and replaced with a new bench containing eleven arches 9 ft. 6 in. centres, 8 ft. wide in the clear, each of which contains eight retorts set in four tiers. They are Ω section, 22 inches by 16 inches by 18 feet through (the width of the house would not permit of longer) with Klönne regenerator furnaces. There is a separate deep furnace for each setting. This form of four-tier setting, with retorts on either side, allows of a roomy combustion chamber, and enables each retort to be uniformly heated throughout without the local or excessive heating which is invariably the case with settings of eight set in three tiers, in which the centre retort over the combustion chamber generally getting excessively hot, and is sooner burnt away than the others. In addition, a setting of eight retorts in four tiers effects economy in floor-space, is a convenient unit to adopt, and is preferable to the older stereotyped settings of eight or nine retorts in three tiers.

The retort-settings do not call for any description (fig. 1 shows cross and longitudinal sections), beyond the remark that they were most carefully built; the author's experience being that attention to details, along with use of only the best quality of fire-clay materials and skilled workmanship are necessary to ensure success—especially with this type of regenerator setting. Any additional expense incurred thereby is soon repaid by the improved working results obtained, and longer life of the settings.

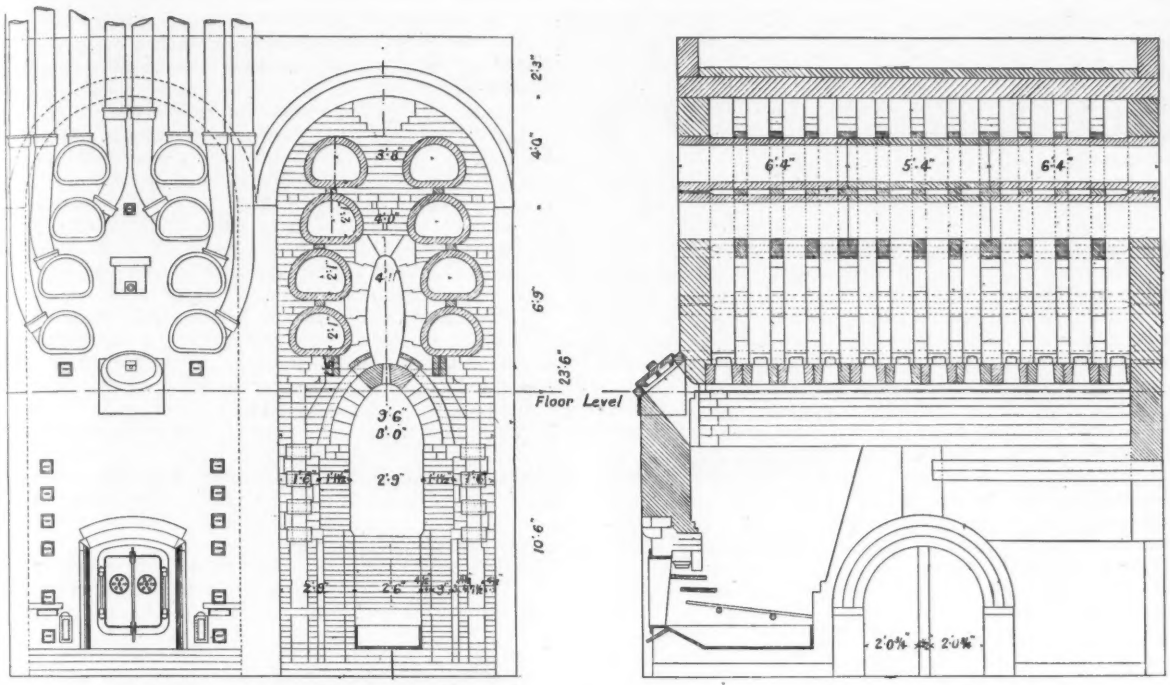


Fig. 1.—The Derby Retort-Settings.

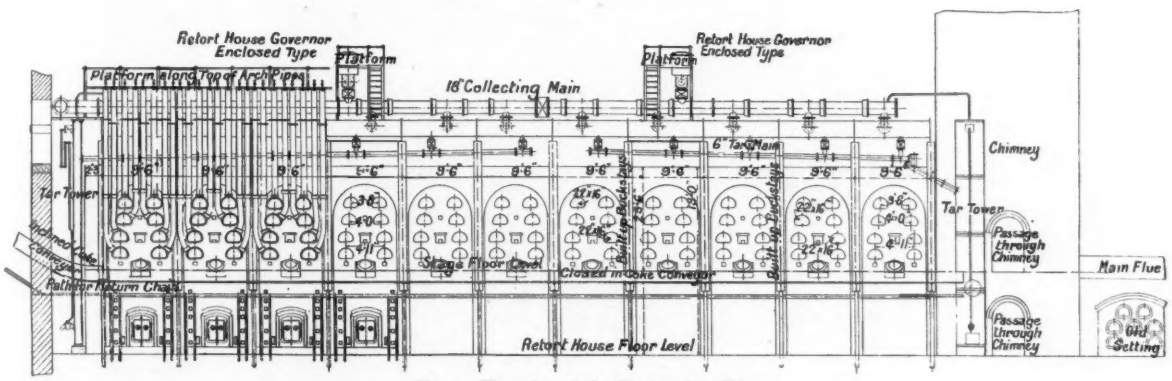


Fig. 2.—Elevation of the Discharging Side.

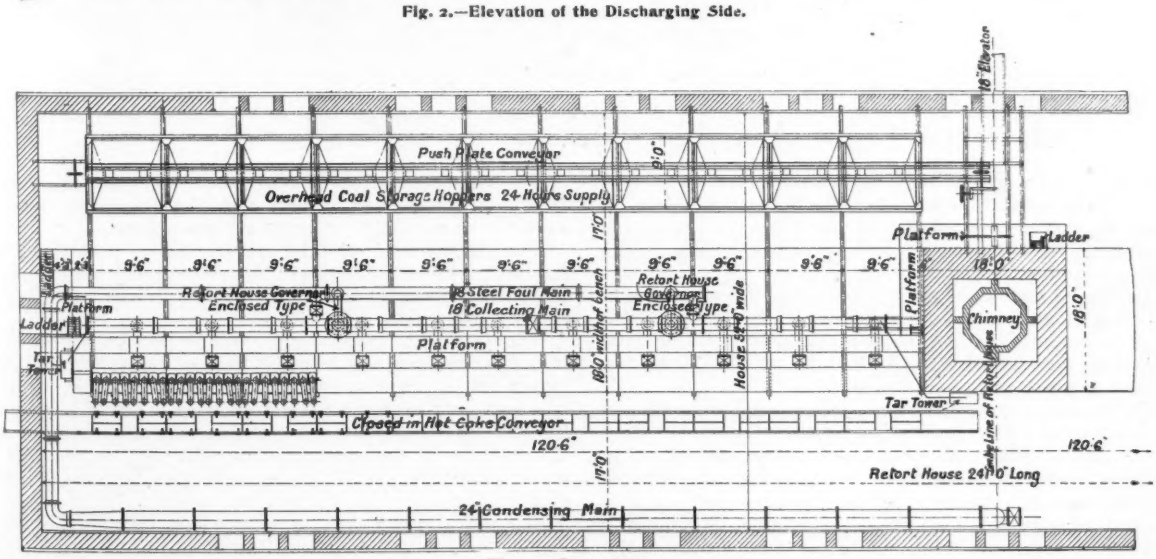


Fig. 3.—General Plan.

They are worked with very little draught; being only $\frac{6}{100}$ of an inch on the primary, and $\frac{7}{100}$ on the secondary air supply, and $\frac{15}{100}$ on the bottom spent gas flue and $\frac{5}{10}$ in the main flue water column. Analyses of the gases from the producer and the spent gases leaving the settings are frequently made and recorded, and typical examples are as follows:—

		Producer.		Flues.
CO_2	..	3·0 to 4·9	..	18·0 to 15·8
O_2	..	None	..	0·4 ,, 3·2
CO	..	28·3 to 26·0	..	None

It will be seen from figs. 3 and 6 that the gas is taken off from the retorts, upon one side of the settings only, by 8-inch diameter ascension pipes. The bridge-pipes are fitted with Bell's "Derby" type of cleaning-out doors vertically over the centre of the ascension and dip pipes. The top of the pipe and lid are both faced; the joint being made gas-tight, similar to self-sealing retort mouthpieces. The lids are simply and effectively secured by a bridge and screw; so that they may readily be taken off and replaced. In addition, a chequered

plate gangway, with handrail in front, is fixed directly over the centre of the bridge-pipes to afford easy and safe access to the pipes, fittings, and valves.

The author's experience with 8-inch diameter ascension-pipes on one side of the bench only is that this is preferable to ascension pipes on both sides, as with through retorts towards the end of charge, when little gas is being made, the gas generally all goes up one pipe, with the result that the other gets hot and dry—tending to cause stopped pipes.

The ascension pipes should preferably be fixed on the charging side, as when the gas is taken off on the discharge side, the coke is liable to be deteriorated by tarry matters on the mouthpieces.

Each dip-pipe is fitted with Simmond's patent anti-dip valve, opened and closed by a weighted lever operated by vertical down rods, which on being released close the valve —converting it into ordinary water-sealed dip-pipe.

Perhaps a brief description of Simmond's anti-dip valve will be of interest, as it is not so well known as it deserves. It consists of a faced slide-valve on the side of the dip-pipe, which when full-open gives an area of 48 square inches, allowing the gas to pass from the retort direct into the hydraulic main without increase of pressure or oscillations such as occur when dip-pipes with even only light seals are used, with *minus* pressure in the hydraulic main. The slide that covers the port of the valve as it descends wedges against the valve face, and forms a gas-tight joint. The short connecting rod from the lever that actuates the valve passes through a stuffing-box gland bolted on top of the hydraulic main, the flange of which is made large enough to cover the hole in the top of the main through which the anti-dip valve may be passed; so it is an easy matter to take out the valve and clean or replace it with another. It will be seen from fig. 7 that the whole forms a neat and compact arrangement. For nine months 80 of these anti-dip valves have been continuously at work on ten beds of retorts, without trouble of any kind. The simplicity and non-interference with the gas-way, along with the ease with which any retort may be worked under hydraulic seal or free gas-way, will commend these anti-dip valves.

The hydraulic main is in one length for the eleven beds, with division plates to isolate each setting, with separate gas take-offs. The whole of the gas-valves are fitted with Drory's indicators; and the tar is removed by means of Dillamore tar-columns at each end of the bench.

Mr. Charles Carpenter's retort-house governors, of the enclosed type, control the suction on the 18-inch diameter foul-gas main; and the author finds that the combination of Mr. Simmond's anti-dip valves with these retort-house governors adds to the efficiency of working and gives improved carbonizing results.

The quantity of carbon formed on the inside of the retorts worked with anti-dip valves is less than one-half that formed on retorts worked with light seals. In the former instance,

Photograph No. 1—Waggon Tipper for Unloading Coal at the Litchurch Gas-Works, Derby.

scurfing once in three months and in the other once every six weeks is sufficient to keep the retorts clear of carbon—it being allowed to accumulate only about ¼ inch to ½ inch in thickness. One retort out of 88 is allowed to stand each day for scurfing.

As already mentioned, special provision is made for dealing with stopped pipes—the *bête noire* of carbonizing. But up to the present there has not been a single stopped pipe, and the whole of the carbonizing plant has worked smoothly without hitch or trouble of any kind.

The retorts are charged by a "De Brouwer" projector and are discharged by a "Jenkins De Brouwer" pusher. Both travel on one side of the house and are capable of easily operating double the number of retorts at present installed. The intention is to add later another eleven settings.

The coal is unloaded by means of a waggon tipper, which lifts up one side from underneath, and the end door of the waggon being released, the coal slides out into a 12-ton hopper fixed below the rails. Photograph No. 1 shows a 12-ton waggon being unloaded. The coal in the hopper is fed by an automatic feeder into a 40-ton per hour coal breaker. By this means the breaker and elevator are regularly fed, which is of importance; and the coal breaker is made perfectly safe when working.

A 50-ton per hour bucket elevator delivers the broken coal on to a push-plate conveyor, which fills the overhead coal storage hoppers of sufficient capacity to hold 24 hours' supply, as shown by fig. 4.

The power required to operate the waggon tipper, coal breaker, bucket elevator, and push-plate conveyor, is obtained from a 43 H.P. "National" gas-engine.

The De Brouwer projector and pusher are propelled and operated by electric motors; the current being generated by a belt-driven direct-current dynamo driven by a high-speed gas-engine.

The coke is discharged by the pusher into a De Brouwer hot-coke conveyor, which runs in front of the settings. This differs from the ordinary type of hot-coke conveyor, in that it is enclosed; so that when the conveyor is not at work, the top forms a chequered plate platform in front of the bench. On each side of the furnace, central with each tier of retorts, are strong double doors. These, when open, form an inclined shoot to direct the hot coke into the conveyor. Photographs Nos. 2 and 3 give a view of each side of the retort-bench These, along with the outline drawings will, without further description, give to the members a clear idea of the carbonizing plant.

The coke as it travels is quenched, and passes up an inclined conveyor at the end of the house; thence on to a jigging screen; and then on to a horizontal conveyor that delivers it on to inclined shoots, fitted with loose swing-doors to break the fall of the coke into overhead storage hoppers, from which carts or railway trucks are loaded. Photograph No. 4 shows a view of the coke conveying and screening plant which is worked by a 22 H.P. "National" gas-engine fixed at the end of the retort-house.

Photograph No. 2—View of the Charging Side of the Retort-Bench, Litchurch Gas-Works, Derby.

Working Costs.

Much diversity and confusion often arise when costs of carbonizing are given for working various types of retort-settings, either for manual labour—which is laborious and trying—or when operated by machinery with the necessary adjunct of coal and coke handling plants. Some include items which form only part of the costs chargeable to the retort-house, whereas others include all kinds of diverse items, which although perhaps reasonable to be charged under this head, unless explained, render any comparison misleading.

The author desires to state explicitly that the costs stated are the actual expenses incurred over the past six months for working ten through settings—being 80 retorts in all, or 160 mouthpieces. They include all outlays which are or should be charged to carbonizing—such as the unloading of coal from railway waggons by means of a waggon tipper, attending to the coal breaker, elevators, and conveyors, gas-engines, coke conveyors, operating the De Brouwer projector and pusher for charging and discharging retorts, opening and closing retort-lids, jacking pipes, running-off tar from tar towers and flushing out hydraulic mains, cleaning mouthpieces and retort-house, scurfing retorts, clinkering and all attention to furnaces, wheeling-out clinker, and all labour upon coke to its being deposited either into overhead storage hoppers or coke store. In other words, the labour charges are inclusive of everything from coal out of waggons to coke into store. The whole of this work is easily performed by five men per shift, and two shifts are worked per diem; the work being arranged so that the men have ample time for meals, and get away each afternoon or morning about 4.30. They start work at 6 a.m. or 6 p.m.

The retorts are worked at a moderate heat, which prolongs the life of the settings; the coal being carbonized at the rate of one cwt. per hour per retort—small coal and slack generally being used. When working six-hour shifts, 6 cwt. charges are put in; eight-hour shifts, 8 cwt. charges; 10-hour, 10 cwt.; and 12-hour, 12 cwt. When working 6 cwt. charges, an extra man is added to each shift.

There is no difficulty in filling up the retorts by means of the De Brouwer projector, and heavy charges of 12 cwt. will push out almost as easily as the lighter charges, provided that the coal is properly carbonized.

The coal carbonized by these ten beds amounts to from 95 to 100 tons per diem, and the cost for carbonizing, which includes all retort-house labour as mentioned, is for six-hour charges 7½d. per ton, and for eight-hour, ten-hour, and twelve-hour charges, 6¼d. per ton. When working the whole bench, which comprises eleven beds, the cost for six-hour work is just under 7d.; and for the longer and heavier charges, 6d. per ton of coal carbonized.

When working six beds at the Cavendish Street works,

Photograph No. 3—View of the Discharging Side of the Retort-Bench, Litchurch Gas-Works, Derby.

carbonizing 60 tons of coal per diem with a De Brouwer combined stoking machine—without hot-coke conveyor—with six-hour charges, the average cost inclusive of coal from carts or stores to coke into store (thrown up a height of 10 feet, if necessary) is 10d. per ton of coal carbonized.

In these figures the wages of the boiler and exhauster men or works foreman are not included, or any other payments than those stated.

The author's experience in working this type of stoking machinery over the past five years is that the cost of repairs and maintenance is small; the machines are reliable and easily operated; and the wear and tear upon the retorts is less than with hand charging and drawing, which is an important point.

The gas used by the high-speed gas-engine to drive the belt-driven dynamo generating current to travel and operate the charging and discharging machines averages 2000 cubic feet per 100 tons of coal carbonized; for waggon tipper, coal breaker, elevator, and scraper conveyor 1800 cubic feet; and for hot-coke conveyor, jigging screen, and scraper conveyor on top of overhead coke storage hopper, 1200 cubic feet. Thus the gas used for power required to operate the stoking machines and coal and coke handling plants averages 50 cubic feet per ton of coal carbonized, which at 1s. 6d. per 1000 cubic feet, is 0·9, or (say) 1d. per ton of coal carbonized.

The cost of the installation complete, as shown in the various illustrations (exclusive of the retort-house—comprising the retort-bench, eleven Klönne retort-settings, steelwork, retort-bench mountings, overhead coal and coke storage hoppers, waggon tipper, coal breaker, elevator, conveyor, hot-coke conveyor, 42 and 22 H.P. gas-engines, fixing same, elevator pit, &c.), is £12,500, and for the twenty-two settings complete the amount will be £20,000.

Carbonizing Results.

The tests given are the results obtained with the time of carbonizing varied from six to twelve hours' duration, and the weight of charges from 6 cwt. to 12 cwt., and also in each case the results are those obtained from similar quality of coal such as may be classed seconds or ordinary Derbyshire with 25 per cent. of good rough Derbyshire coking slack added; the author being of opinion that trials carried out with the lower grades of coal would be of more value than if South Yorkshire or other high-class gas coals had been used, although the results obtained are of course correspondingly lower. There is little doubt that it is to the lower grades of coal that gas makers will in future require to turn their attention. For the purpose of comparison, the results are given of tests made with the better class of Yorkshire screened coal and small gas nuts, and slack.

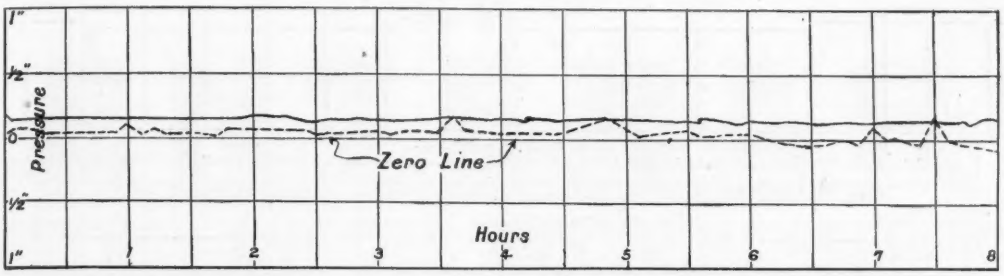


Diagram of Pressures when Working with Carpenter's Retort-House Governor and Simmonds's Anti-Dip Valves.

[The unbroken line shows the pressure at the top of the ascension-pipe; the dotted line, that at the bottom.]

Care was taken to work all retorts under a slight *plus* pressure; so that there would be only coal gas, not a mixture of coal gas *plus* spent furnace gases, which are simply harmful diluents.

So that the conditions may be known under which the coal was carbonized, a pressure chart is given which shows, in tenths of an inch water column, the pressure of gas in the collecting main with Carpenter's retort-house governor, and also inside the retorts with Simmond's anti-dip valves, open during the whole period of an eight-hour charge.

The readings were taken simultaneously every minute with a King's gauge indicating one-hundredths of an inch pressure or vacuum. It will be noticed 1½-tenths pressure on the top of the ascension pipes gives ½-tenth *plus* pressure to zero inside the retorts. The pull on the outlet of the retort-house governors was maintained at between 3 and 4 inches vacuum; the inlet at 1½-tenths of pressure. The variation during the eight hours was less than one-tenth of an inch, as shown by the firm line on the pressure chart. The dotted line indicates the pressure inside the retorts. The slight variations are due to the times of charging; and, as will be seen, the retorts are worked if anything on the pressure side.

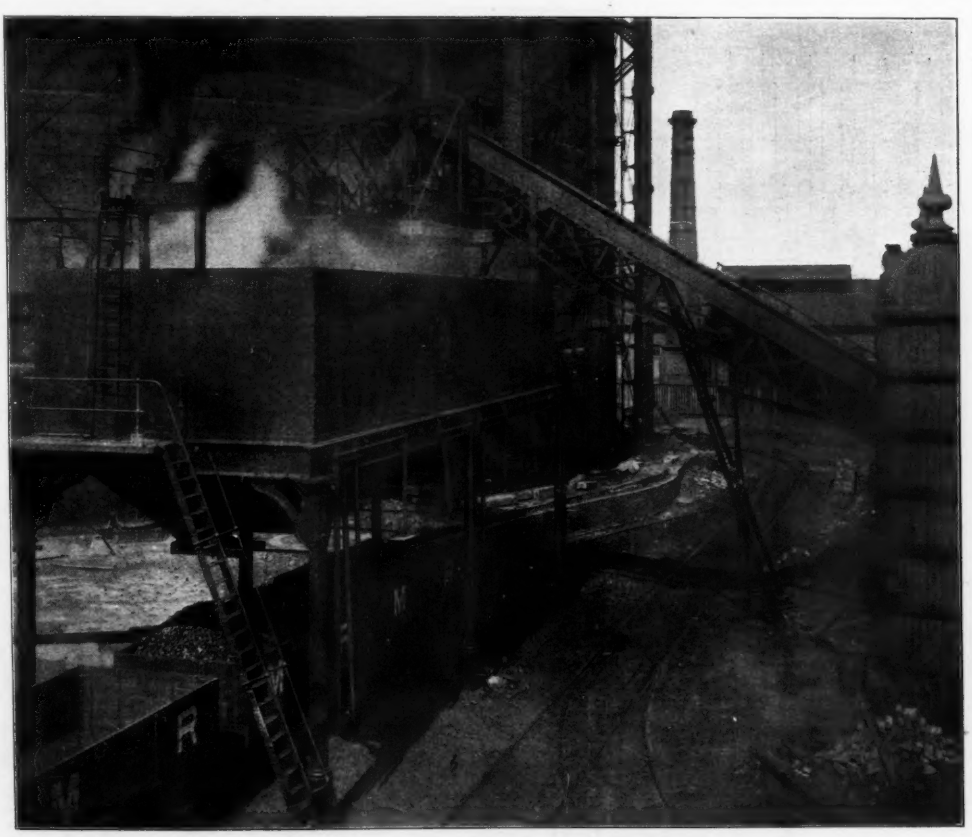
Retorts are much more porous than many think, with the result that pressure on the retorts during the early part of the charge may mean loss of the richest gas, and vacuum serious depreciation when the gases coming away are the poorest.

Pressure measured in tenths or hundredths of an inch, unless taken with sensitive gauges fixed close to their work, are apt to be misleading; and when working with anti-dip valves, it is most important to be in a position to know exactly the pressure or vaccum inside the retorts during the whole period of carbonization.

Bye-Products.

The proportion which the secondary products of gas-making contribute to the revenue has, during the past decade, undergone considerable variation; and their value will no doubt continue to fluctuate in the future. While it is impossible to control prices, the production and utilization of bye-products is in a measure within the power of those responsible; and much depends upon turning them to profitable account. The author's experiments were partly undertaken to ascertain what effect varying the weight and the period of carbonization had upon the production of the residual products.

Gas-Coke.—This is now the most important of the bye-products, and although any endeavours towards improvement of its quality must, within certain limits, so far as gas makers are concerned, be subordinated to the main end of obtaining the maximum yield of gas of highest illuminating power (or perhaps rather calorific value) from the coal carbonized, the value of this fixed residue of coal distillation is of such importance that in districts favourably situated, it may return as much as one-half of the cost of the coal. Hence any appreciable improvement in the quality of the



Photograph No. 4—The Coke Screening and Storage Plant at the Litchurch Gas-Works, Derby.

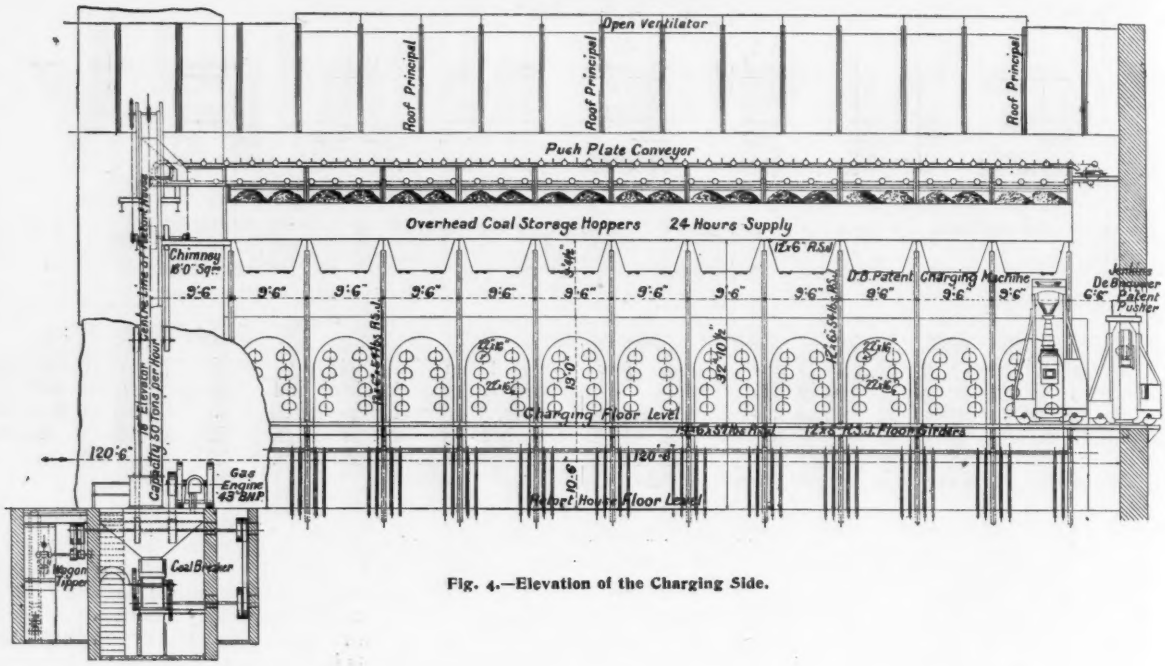


Fig. 4.—Elevation of the Charging Side.

coke produced by modification of the carbonizing process, is worthy of investigation.

The value of this fuel, which burns without smoke or soot, is being more and more appreciated, as its economic and other advantages become recognized. With the result, similar smokeless fuels are offered to the public under other names, with many superlatives giving in glowing terms the many advantages attending their use. The coke produced should as far as possible be both chemically and physically suited to the special requirements of the district, and always suitably prepared for domestic use, in which there is an increasing field of usefulness. Obviously upon the degree of fusibility and the composition of the coals depends its caking properties; and these determine the quality of the coke produced. Lean coals, which do not cake well together and produce a soft friable coke, may by the due

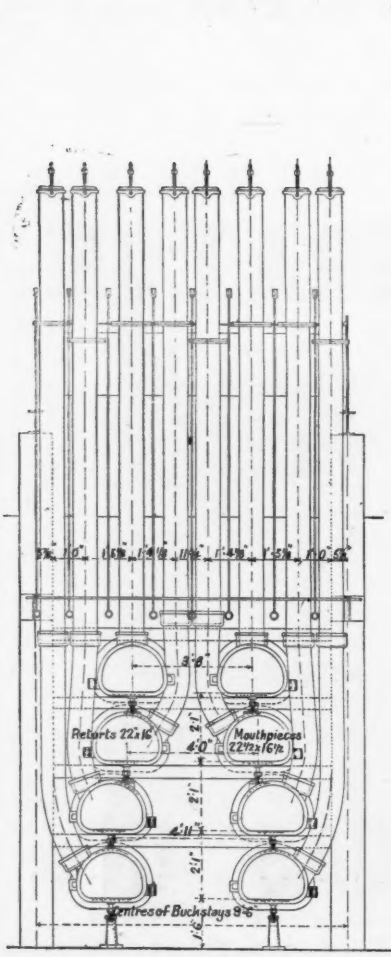


Fig. 5.—Front Elevation.

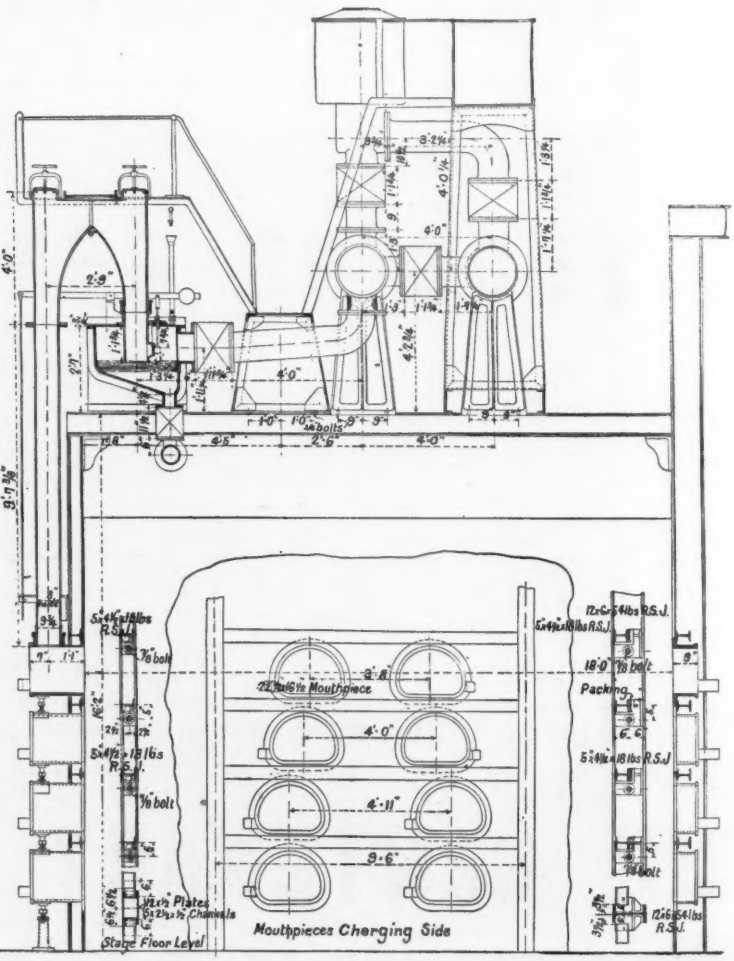


Fig. 6.—Transverse Section.

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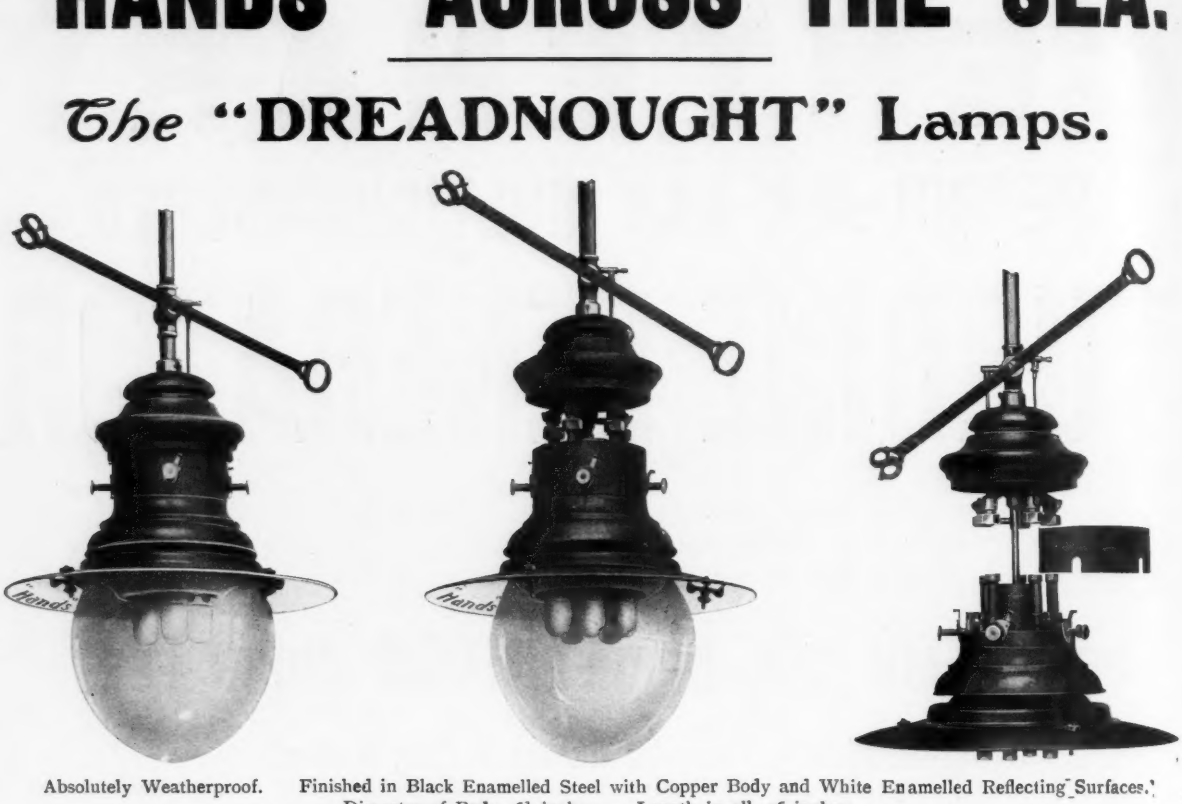

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admixture of 25 per cent. of good coking slack be made to produce a better all-round coke.

The slight packing of the coal in the retorts makes the coke produced more dense and less friable. The particles lie more closely together, which tends to fusibility; and this, with a longer period of carbonization, produces coke of more uniform quality and better appearance, upon which much depends.

The author's experiments with charges of six, eight, ten, and twelve hours duration—the weight of charge being varied directly proportional to the time of carbonization—prove conclusively that heavy charges, by which the period of distillation is prolonged, are a means whereby a higher grade of coke is produced, the colour is brighter and more lustrous, and the coke is more dense and less friable—of great importance if it has to be transported any distance.

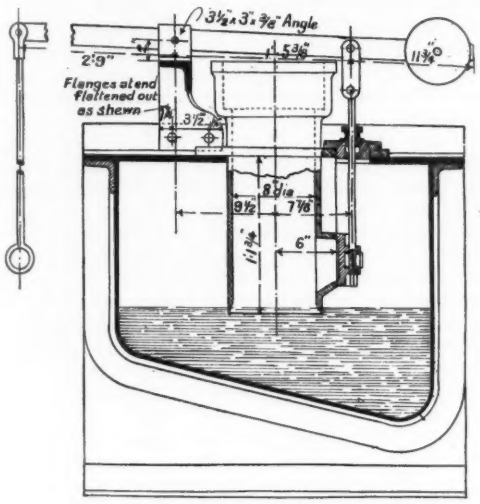

Fig. 7.—Sectional Elevation of the Simmonds Valve Dip-Pipe.

Below are analyses of coke produced from medium Derbyshire coal, mixed with 25 per cent. of good rough Derbyshire slack, carbonized in periods of six to twelve hours:—

Duration of Charge.	Weight of Charge.	Carbon.	Volatile Matter.	Sulphur.	Ash.	Moisture	Real Specific Gravity.
	Cwt.						
6 hours .	6	84·40	1·06	1·89	11·98	0·03	1·598
8 ,, .	8	81·43	0·75	1·94	9·65	1·97	1·540
10 ,, .	10	86·78	2·67	1·76	8·64	0·64	1·658
12 ,, .	12	86·21	2·30	1·75	9·81	0·54	1·686

It will be noticed from the percentage of ash present in the coke that the coal from which it was produced is, as stated, of only medium quality—in fact, with four or five hour charges it would entail great loss in consequence of being so soft and crumbling up into breeze. As would be expected, with more drastic carbonizing, the sulphur present decreases, and there is a decided increase in the specific gravity as the weight and duration of the charges are increased.

The experiments indicate that heavier charges with longer periods of carbonization produce a more dense and improved quality of coke, better suited for many trade purposes. But it should be borne in mind that if the coke is very hard and dense, it is more difficult to kindle, and not so well adapted for domestic use.

The results obtained from 24 hours' experimental tests of coke made for sale and used on the furnaces, per ton of coal carbonized, are as follows:—

Coke Made for Sale.

Duration of Charges.	Large Screened Coke.	Small Screened Coke.	Screened Breeze.	Coke Dust.	Total.
6 hours . . .	7·69	2·06	1·96	0·54	12·25
8 ,, . . .	8·07	1·87	1·80	0·42	12·16
10 ,, . . .	8·27	1·81	1·59	0·41	12·08
12 ,, . . .	8·55	1·79	1·33	0·37	12·04

Coke Used on Furnaces.

Duration of Charges.	Cwt.	Percentage of Coke Made.	Pounds of Coke per 100 lbs. of Coal.
6 hours . . .	1·89	15·35	10·24
8 ,, . . .	1·95	16·04	11·23
10 ,, . . .	2·10	17·39	12·17
12 ,, . . .	2·13	17·61	12·32

From the above summarized returns, it will be seen that the quantity of large coke for sale increases with the duration of the charges; and that there is less breeze made, due to the coke being harder and less friable. It appears that with larger and heavier charges of longer duration the percentage of coke used in the furnaces somewhat increases.

Ammonia.—Numerous processes have been devised for the production of NH_3 by synthetic and other methods; but so far these have not proved remunerative, though at Notoddes, in Norway, large works are being erected for the manufacture of nitrates from the atmosphere by the Birkeland-Eyde process, by means of electric flame chambers in which the temperature exceeds 3000° C. The nitrous gas produced is converted into nitrate of lime containing about 13 per cent. of nitrogen.

However, up to the present the principal sources of supply are from gas-works, coke-ovens, and shale and iron works; but by far the largest contributors is still the gas industry. Last year the total production of ammonium sulphate in the United Kingdom was 317,000 tons, of which gas-works contributed 165,000 tons. Hence this bye-product is not only of great importance, but so far is fortunately a profitable one, as it may yield a return of over 2s. per ton on the coal carbonized.

Derbyshire gas-coals generally contain from 1 to 1·3 per cent. of nitrogen in a form favourable to the production of ammonia during the process of destructive distillation. Unfortunately, only about one-fifth is recovered in saleable form, as, under the conditions prevailing, serious loss occurs through dissociation, and destruction of ammonia by decomposition after formation, due to the temperature of carbonization, with the result that more than twice the quantity obtained as ammonia appears as nitrogen in the gas, one-half or more remains in the coke, a small proportion forms cyanogen compounds, and there is also some in the tar.

The results obtained by varying the weight and period of carbonization are given below, and obviously will vary with the quantity of nitrogen in the coal, the temperature of distillation, and conditions prevailing:—

Ammonia Obtained per Ton of Coal Carbonized.

Duration of Charges.	In Virgin Liquor.	Condensed from Drain Boxes and from Tar.	From the Gas.	Total Ammonia.	Nitrogen in the Coal Recovered.
	Lbs.	Lbs.	Lbs.	Lbs.	Per Cent.
6 hours . . .	4·03	0·35	2·88	7·26	0·216
8 ,, . . .	4·26	0·39	3·61	8·26	0·245
10 ,, . . .	4·40	0·50	3·55	8·45	0·248
12 ,, . . .	4·30	0·42	3·68	8·50	0·253

The experiments indicate that slower carbonization tends towards an increase in the production of ammonia, there being an increase of over 17 per cent. between charges of six and twelve hours duration.

Coal-Gas Tar.—Obviously, upon the kind of coal carbonized depends the condensible hydrocarbon distillates, which are of extremely complex nature, grouped under the generic name of tar. In addition, this bye-product varies with the time and temperature of carbonization. In order to differentiate between the various kinds of tar now produced from various sources, it is advisable to designate the product from gas-works as coal-gas tar. Although the return for this valuable product is not at present commensurate with its importance, it seems to the author that it might be worth while to grade the tars produced so as to sell them to better advantage. For instance, it is probable that a large demand for tar will arise for road-making; the special quality required being that it will easily set and bind the road materials together. For this purpose the more easy condensible and heavier tars are the most suitable, which means the hydraulic main tars freed from water.

It is well known that if the supply of any product exceeds only slightly the demand, prices are depreciated out of all proportion to the amount of the surplus. This is, unfortunately, the case with coal-gas tar at the present

time, with the result that the return obtained for this bye-product is only about 1s. per ton of coal carbonized.

Below are the results obtained by carbonizing similar coal under the same conditions as those already given for make of coke and ammonia :—

Tar Made per Ton of Coal Carbonized.

Duration of Charge.	Hydraulic Main and Condensers.		Tar Extractor and Drain Boxes.		Total.
	Gallons.	Specific Gravity.	Gallons.	Specific Gravity.	Gallons.
6 hours. .	9·68	1·192	0·96	1·126	10·64
8 ,, . .	10·01	1·173	1·70	1·118	11·71
10 ,, . .	10·20	1·168	2·15	1·110	12·35
12 ,, . .	10·55	1·160	2·29	1·108	12·84

It is noticeable that with heavier charges of longer duration the quantity of tar produced is greater, and found to be lighter and much thinner, and in addition, the gas leaving the condensers carries forward a larger quantity of light, tarry matters—to be removed by the tar extractor.

The author has not been able to fractionate, by distillation, the four samples of tar produced; but the firm of tar distillers who take the tar have remarked upon it being thinner, and that it contains more light oils than formerly.

Gas Made.

Variation in Make and Quality of Gas.—In order to determine the quantity and quality of gas given off as the process of distillation proceeds, 32 retorts were all charged within one hour with about 8 cwt. of coal in each; the heat of the retorts being regulated for eight-hour charges. The gas made was isolated, separately measured, and tested each half hour for illuminating power, calorific value, sulphuretted hydrogen, bisulphide of carbon, and carbonic acid. The results that were obtained are given in Appendix I.

During the first four hours the gas is given off at a fairly even rate. But the quality gradually declines from 19·49 to 14·40 candles; and over the next four hours from 14·40 to 5·56 candles. If distillation be continued for another hour-and-a-half, the gas produced is only of about two candles, and the calorific value is down to 52·7 calories. Thus if the carbonization is carried beyond a certain limit, the effect is only a small gain in quantity at the expense of the quality. For instance, during the extra 1½ hours that carbonization is prolonged, the gain in candle feet is only 1·6 per cent. of the total, whereas the reduction in candle power is over 7 per cent.

The reduction in candle power from 19·49 to 5·56 candles or less, and in calorific value from 162·6 to 73·4 calories per cubic foot at the beginning and the end of the period of distillation, will indicate the importance of regular charging at short regular intervals, so that the gas made may be of uniform quality.

It will be observed that the calorific value is relatively higher per candle for the lower candle power gas, even with the No. 2 "Metropolitan" test-burner; but if tested with the old No. 1 "London" burner, which unduly depreciates all gas of a lower quality than 18 candles, the detraction increases as the candle power decreases. The difference is very striking.

The author expected to find the carbonic acid, sulphuretted hydrogen, and bisulphide of carbon to increase relatively to the gas made towards the end of the period of distillation; but this does not appear to be so. The carbonic acid is fairly regular throughout, so long as the retorts are worked upon the pressure side; but a slight vacuum, especially towards the end of the period of distillation, rapidly increases the percentage of carbonic acid present. The sulphuretted hydrogen is highest during the first hour, and the bisulphide of carbon during the fourth and fifth hours. But later on both these impurities appear to relatively decrease.

Charges of Six, Eight, Ten, and Twelve Hours' Duration.—On the chart is plotted the gas made, candle power, net calorific value, and impurities present in the crude gas each hour during trials of six to twelve hours' duration. The temperature of the retorts was as near as possible kept equal for each trial; and the gas made, quality, and impurities tested each hour over the whole 24 hours.

The four lines on the top of the diagram indicate the gas made each hour during the tests. Both horizontal and vertical small divisions represent 2000 cubic feet; so that each wave-line depicts the actual variation in the gas made from hour to hour, and the same applies to candle power and calorific value.

The make of gas per hour and candle power are most regular with six-hour charges, and appear to vary most as the time of carbonization is prolonged—due no doubt to the periods between the times of charging being longer. On the chart (which is reduced from larger diagrams made to indicate variations in make of gas and candle power), it is interesting to observe a series of reverse curves. As the make increases so the candle power decreases, and the calorific value curve follows to some extent the candle power curve, showing a certain relation between the two.

It will be seen from Appendix II., which gives a summary of the results obtained, that so far as total sperm value is concerned, it appears to make little difference, whether the coal is carbonized during six, eight, ten, or twelve hour periods. With the lighter charges and the shorter time of

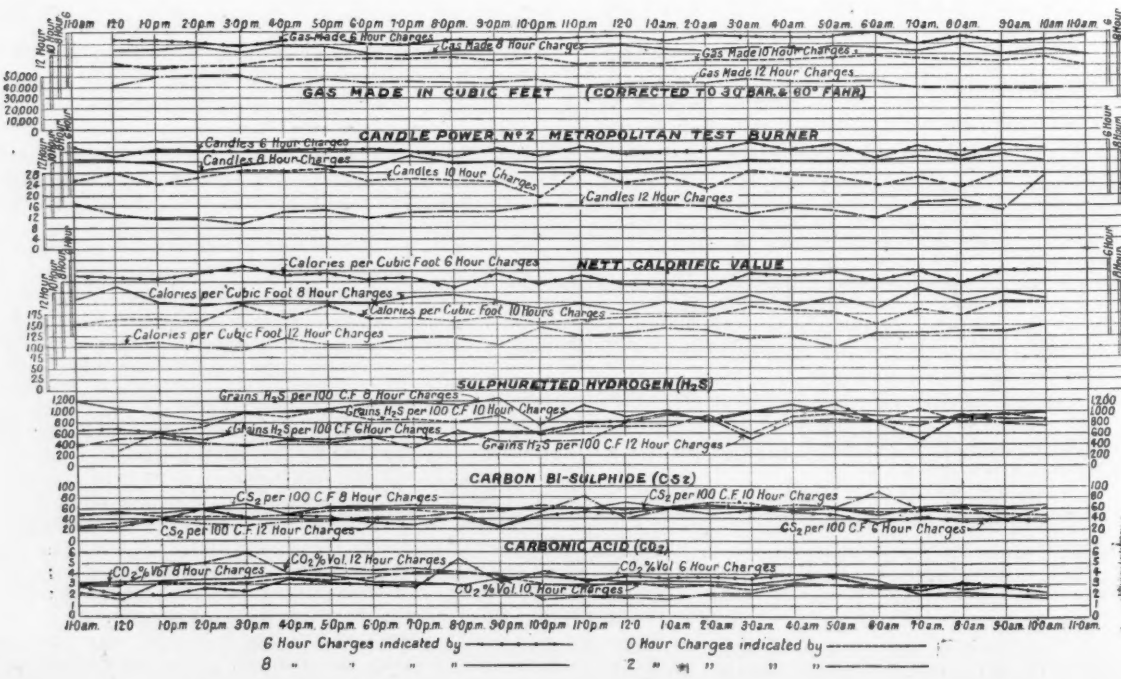
GAS MADE IN CUBIC FEET (CORRECTED TO 30" BAR. & 60° FAHR.)
Gas Made 6 Hour Charges
Gas Made 8 Hour Charges
Gas Made 10 Hour Charges
Gas Made 12 Hour Charges
CANDLE POWER Nº 2 METROPOLITAN TEST BURNER
Candles 6 Hour Charges
Candles 8 Hour Charges
Candles 10 Hour Charges
Candles 12 Hour Charges
NETT CALORIFIC VALUE
Calories per Cubic Foot 6 Hour Charges
Calories per Cubic Foot 8 Hour Charges
Calories per Cubic Foot 10 Hours Charges
Calories per Cubic Foot 12 Hour Charges
SULPHURETTED HYDROGEN (H_2S)
Grains H_2S per 100 C.F. 8 Hour Charges
Grains H_2S per 100 C.F. 10 Hour Charges
Grains H_2S per 100 C.F. 6 Hour Charges
Grains H_2S per 100 C.F. 12 Hour Charges
CARBON BI-SULPHIDE (CS_2)
CS_2 per 100 C.F. 8 Hour Charges
CS_2 per 100 C.F. 10 Hour Charges
CS_2 per 100 C.F. 12 Hour Charges
CS_2 per 100 C.F. 6 Hour Charges
CARBONIC ACID (CO_2)
CO_2 % Vol. 8 Hour Charges
CO_2 % Vol. 12 Hour Charges
CO_2 % Vol. 6 Hour Charges
CO_2 % Vol. 10 Hour Charges
6 Hour Charges indicated by
8 " " " "
10 Hour Charges indicated by
12 " " " "

Chart Showing Gas Made, Candle Power, Net Calorific Value, H_2S, CS_2, and CO_2 present in Crude Gas each Hour.

carbonization, the quantity of gas made is less, but the candle power is higher; and with the longer periods, the make increases while candle power decreases.

It is surprising to find so little variation in the total carbonic acid present in all four tests. The average difference is only 3·10 to 3·25 per cent. by volume in the crude gas.

There do not appear to be any definite deductions to be drawn from the sulphur impurities present—only to remark that in all four tests, when the quantity of sulphuretted hydrogen given off is greatest, then also the bisulphide of carbon is highest.

The naphthalene is considerably less in quantity in the purified gas (without special treatment for this troublesome constituent) when working heavier and longer charges. It is on an average about 50 per cent. less—due no doubt, to some extent, to the solvent action of the lighter tarry vapours.

The results are given of 24-hour trials with eight-hour charges of high-class Yorkshire Silkstone coal with the fine slack removed, small nuts, and rough slack, so far as make of gas, candle power, and coke produced are concerned.

Yorkshire Silkstone Coal.	Gas Made per Ton of Coal 30" B and 60° Fahr.	Illuminating Power, No. 2 "Metropolitan" Burner.	Sperm Value Per Ton of Coal.	Coke and Breeze Per Ton of Coal.			
				Large Coke.	Small Coke.	Coke Breeze.	Coke Dust.
	Cub. Ft.	Candles.	Pounds.	Cwts.	Cwts.	Cwts.	Cwts.
Screened . .	12,788	16·25	712	10·49	0·63	0·49	0·32
Small nuts .	12,544	15·35	660	9·77	1·40	1·28	0·39
Rough slack .	12,607	15·00	648	9·51	1·79	1·08	0·32

The above returns are not from the highest class of Yorkshire silkstone, which gives over 13,000 cubic feet per ton of 16½-candle gas, but from such coals as can be readily obtained at moderate prices.

The experiments indicate that heavy charges with longer period of carbonization tend to give higher and better results from the coal, more especially as regards the yield of bye-products; and the author feels that the subject is one well worth more extensive and closer investigation than he has been able so far to give it.

APPENDIX I.—*Quantity and Quality of Gas Produced each Half-Hour from* 32 *Retorts, "D" Section,* 22 *in. by* 16 *in. by* 18 *ft. through, all charged simultaneously with about* 8 *cwt. of Medium Quality Derbyshire Gas Coal and* 25 *per cent. of Slack added.*

Time.	Gas Made each Half-Hour.	Candle Power by No. 2 Metropolitan Test Burner. Candles.	Candle Feet Produced each Half-Hour.	Calorific Value.		Calories per Candle.	CO_2 Per Cent. by Vol.	SH_2 per 100 Cubic Feet. Grains.	CS_2 per 100 Cubic Feet. Grains.
				Gross Cal.	Nett Cal.				
1.0	4,100	18·57	15,228	175·7	161·2	8·68	3·4	911	45·6
1.30	9,900	19·49	38,590	167·2	155·1	7·95	3·0	1005	31·6
2.0	10,200	18·26	37,250	177·6	162·6	8·90	3·0	969	44·0
2.30	9,700	18·22	35,347	150·0	136·9	7·51	3·0	770	41·6
3.0	9,500	17·02	32,338	152·7	141·8	8·33	2·9	..	48·2
3.30	9,500	15·47	29,393	136·4	125·9	8·14	3·4	456	58·7
4.0	9,600	13·05	25,056	127·6	117·7	9·01	4·5	613	59·5
4.30	9,600	14·33	27,513	118·8	110·1	7·68	4·0	1413	57·4
5.0	8,500	15·40	26,180	117·7	110·3	7·16	3·2	524	54·3
5.30	7,700	14·05	21,637	121·0	113·7	8·09	3·0	681	65·0
6.0	7,500	12·93	19,395	121·2	112·4	8·69	2·4	702	65·0
6.30	7,100	12·58	17,864	113·3	105·5	8·38	2·6	544	55·5
7.0	7,200	10·76	15,492	109·0	100·6	9·35	3·0	424	65·8
7.30	6,600	9·92	13,094	95·9	88·1	8 88	3·0	471	63·2
8.0	4,800	7·35	7,056	88·7	82·3	11·20	3·6	407	48·5
8.30	4,800	7·86	7,545	86·4	79·2	10·08	3·4	340	32·0
9.0	5,400	5·56	6,005	79·7	73·4	13·20	4·0	440	28·0
9.30	3,200	4·55	2,912	68·1	62·1	13·65	..	..	..
10.0	3,800	2·03	1,543	52·7	49·1	24·18	..	..	..
10.30	4,700	1·73	1,626	..	..	..	..	..	..
	143,400		381,064						

APPENDIX II.—*Summary of Results Obtained from Medium Derbyshire Gas Coals with* 25 *per cent. of Good Rough Derbyshire Coking Slack Added with Charges of* 6, 8, 10 *and* 12 *Hours' Duration.*

Duration of Charges.	Number of Retorts.	Average Weight of Coal per Charge.	Gas Made per Ton of Coal 30" Bar. 60 F.	Candle Power No. 2 Metropolitan Test Burner.	Gas Made per Retort 22 ins. by 16 ins. by 18 ft.	Sperm Value per Ton of Coal in Lbs.	Calorific Value of Gas.		Impurities in Crude Gas.			Coke per Ton for Sale.		Tar per Ton of Coal.	Ammonium Sulphate per Ton of Coal.
							Calories per Cubic Foot.	Calories per Cubic Foot.	CO_2 per cent. Volume.	SH_2 per 100 Cubic Feet in Grains.	CS_2 per 100 Cubic Feet in Grains.	Coke.	Breeze.		
		c. q. Lbs.	Cubic Feet.		Cubic Feet.		Net.	Gross.				Cwts.	Cwts.	Gallons.	Lbs.
6 hours. .	80	6 0 20	10,594	16·31	13,090	592	135·75	149·8	3·20	736	43·40	9·75	1·96	10·64	29
8 ,, . .	80	7 3 12	11,245	15·59	13,248	601	130·77	141·6	3·19	996	60·20	9·94	1·80	11·71	32
10 ,, . .	80	9 2 17	11,499	14·53	13,318	574	123·00	134·3	3·10	814	56·10	10·08	1·59	12·35	33¾
12 ,, . .	80	11 2 4	11,463	14·77	13,178	580	122·00	134·6	3·25	620	47·40	10·34	1·33	12·84	34

SOME ADVANTAGES AND DISADVANTAGES OF A HOT-COKE CONVEYOR.

By ROBERT WATSON, of Doncaster.

There is little doubt that, while coke conveyors pay on large works, a line of demarcation, dividing gain from loss, exists on the scale running down to the smaller undertakings. The line is probably lower than many are disposed to think; and it is in support of this suggestion that the following paper is offered. It will be admitted that in the smaller works a conveyor used solely for the purpose of removing coke does not result in great pecuniary gain. The charges due to interest on capital, depreciation, wear and tear, and breeze production are factors of such moment that they tend to neutralize the benefit to be derived from reduced labour costs. When, however, the indirect advantages are fully considered and added to the direct saving of labour, the economic possibilities of conveying plant become much more certain. The incidental gains are many, and include the quickening of retort-house operations by the rapid removal of the coke; the facility with which this can be stacked in the yard; and the applicability to screening methods where coke is graded for sale.

Among the indirect services thus rendered by a conveyor the last-named is not the least important; and in relatively small works the full value of conveying plant is more easily appraised from the point of view of the coke yard than from that of the retort-house. The monetary necessity of preparing coke suitable for the varied needs of customers is too well recognized to be discussed here. The work is becoming part of the routine of most coke departments, and special steps have to be taken to achieve the end in view. These steps may consist of the provision of a breaking and screening plant independently dealing with the coke after removal from the retort-house, or of plant connected with, and fed by, conveying appliances—a combination which at once seems to commend itself.

It was primarily the necessity of finding an outlet for surplus coke that brought the general question to the attention of the writer. Some 10 to 12 per cent. of Doncaster coke went outside the home district at cut-prices, involving an annual loss of £250 to £300; and to avoid this, it was

decided to stimulate local custom by offering broken coke—a branch of work which had not previously been undertaken. Consideration of two schemes, one covering a power breaking plant with elevator, screen, hoppers, &c., fed by barrowed coke, and the other of much the same apparatus worked in combination with a coke-conveyor, led to the adoption of the latter. The question which caused doubt was whether the scale of work warranted the capital outlay and the probably disproportionate maintenance charges of a conveying plant. In Doncaster, gas-making operations were carried on in one of two retort-houses; the maximum daily make being about a million cubic feet and the minimum only 400,000 cubic feet. The effect of capital and maintenance charges per ton of coal handled might therefore easily prove to be relatively heavy and outbalance any possible saving in working. To keep the capital expenditure within reasonable limits, the writer contemplated the use of a conveyor on one side only of the through retort-beds. It was thought that by the concentration of coke on to a single chain, the wear and tear charges would also be reduced. The retort-house had previously been equipped with two sets of West's manual stoking machines, one on each side of the bench. The beds were heated by single furnaces; and to feed these the whole contents of through retorts were used—the half on the furnace being drawn direct, and that on the dummy side backed by rake to the generator side, and then drawn in the usual way. Such a use of manual rakes obviously suggested that twin conveyors were scarcely necessary, and that a chain put down on the dummy side of the beds would carry the whole of the coke if partly pushed and drawn in the way indicated. This method, from the point of view of the men, was certainly preferable to the hard and unpleasant task of barrow wheeling. The somewhat reduced capital and maintenance charges thus rendered probable, led to the installation of a combined coke and screening plant, on the lines suggested; and it may be said at once that, in the light of nearly four years' experience, the decision has not been regretted.

A general consideration of the question from the humanitarian aspect is altogether in favour of mechanical conveyors. The removal of 2 cwt. to 3 cwt. of red-hot coke in heavy unwieldy barrows scarcely seems the work of human beings; and one will welcome the time when modified costs will bring such means within the reach of all gas undertakings. Each reversion to barrow wheeling on the occasion of a breakdown accentuates this feeling in the minds of both manager and men. The use of a conveyor serves as a further benefit to the retort-house staff in that the continuous removal of the coke subjects them to much less heat during the process of drawing, and affords greater leisure between the draws by shortening the time occupied in stoking.

Obviously, the acceleration of charging operations by the rapid removal of coke is also of consequence in the general and economical working of the retort-beds. It is particularly the case with all forms of charging plant, whether manual or power. But this feature is too well recognized to warrant discussion. The fact that the hot coke is to be dealt with by a machine makes generally for more equal and better charging. There is ever a tendency in the usage of barrows to lessen the quantity of coal placed in the retort in anticipation of some relief when the resultant small bulk of hot coke has to be wheeled away. It frequently happens, too, that the bottom retorts are lightly charged for another reason—that of the difficulty of filling the coke barrow, since the mouthpiece precludes full loads without much spilling and subsequent work of clearing up. These and similar factors (apart from stacking and screening facilities) make the method a useful auxiliary to the retort-house. They are nevertheless difficult to appraise or to include in the profit and loss account of mechanical conveying.

The two prominent disadvantages incidental to conveyors are found in the wear and tear to which the plant is undoubtedly subjected, and the amount of breeze produced during the working of the chain and delivery of coke into the yard. Both are responsible for some anxiety, and would appear at first to neutralize the gains, direct and indirect, otherwise obtained. They may, however, be kept within certain limits; but this paper will serve a useful purpose if the discussion elicits some suggestions as to the narrowing of these limits. It is the fear of wear and tear and of breeze charges that acts as a deterrent to the adoption of conveyors so far as the smaller works are concerned.

The Doncaster coke-conveyor, of the West pattern, was first installed to serve a retort-house 91 feet long, equipped with seven beds of through retorts. The hoppers were placed some distance from the retort-house, in view of a contemplated extension of the latter. The chain was in one continuous length, travelling, after leaving the horizontal, up an incline of 15° to the hoppers. Shoots were provided on the inclined section, to enable a portion of the coke to be discharged on the ground where required; the balance passing to the top, through the breaker or its bye-pass, into the screen and hoppers. The general arrangement is shown in figs. 1, 2, 3; the position of the inclined conveyor being indicated by dotted lines.

The plant was well designed, and worked all right; but there were several troubles, in the way of wear and tear, and water saturation of the coke. The first was principally due to the fact that the chain, being in one length and actuated by a sprocket wheel at the top of the inclined section, was subjected to some little strain. The chain was kept taut by an admirably arranged heavy tension wheel suspended in the return path. The double strain, however, gradually wore the links, as these rode the teeth of the sprocket-wheel, with the ultimate result of breakage. In the modified plant, this strain has been eliminated; and the conveyors are now working under normal conditions and satisfactorily. The other trouble was due to the over-quenching of the coke; and this is not an unknown thing with conveying plant. The bend in the conveyor trough, as this left the retort-house, held up a quantity of water, despite the provision of the usual overflow arrangement. The coke and breeze were consequently saturated with water, to the disadvantage of the screens and the detriment of customers. The sprinklers had to be reduced in order to limit the water; but there was ever difficulty in adjusting these to suit varying quantities of coke on the chain.

Two years ago, the retort-house was extended to accommodate five additional through beds; and the conveyor was adjusted to suit the new conditions. To obviate the difficulties referred to, the conveyor was converted into two sections, whereby the horizontal or house chain could work independently and feed its coke on to the inclined chain (see fig. 4). There have been distinct gains resulting from the alteration. The division of the continuous chain into two lengths, with separate drives, and the replacement of the overhead tension wheel by ordinary gear at the foot of the conveyor, have reduced the wear and tear. The renewal of links is now a comparatively easy matter. The coke is in a better condition, and can be more effectively screened, since the water flows naturally from both the horizontal and the inclined sections into the sump hole, leaving the coke to go forward practically dry. The difference in possible moisture is best indicated by the fact that the hopper coke does not, under normal conditions, contain more than 2 to 3 per cent. of moisture; while the small dust breeze collected at the bottom of the conveyor occasionally holds as much as 18 to 20 per cent. Dust breeze carried along the conveyor would seem to serve a useful purpose as a moisture absorbent. Tests of the coke breeze taken from the first hopper show a moisture average of some 13 per cent.; the coke itself being to all intents and purposes dry. This relative dryness is of considerable importance so far as the local coke trade is concerned.

In dealing with the question of breeze, it should be borne in mind that this is produced whether the barrow or the conveyor is in use. The latter is, of course, the greater offender, but not to the extent which is generally supposed. As a matter of fact, the conveyor, *per se*, does not increase the breeze production to any serious degree. This has been previously pointed out and proved by tests. Results necessarily vary with intrinsic hardness; but the following data have been obtained with coke from the same class of South Yorkshire (nut) coal and under like conditions of carbonization. Where removed by barrow, the coke was taken into the yard, quenched, and thrown out in the usual way; in the case of the conveyor it was collected at the extreme end of the inclined section (see point B, fig. 2). In all the tests the coke was carefully screened by hand into large coke (over 2-inch mesh), domestic coke (over 1-inch), smithy coke (over ½-inch), and small dust breeze (through ½-inch). The average results were as follows:—

TABLE I.

	Coke Removed by Barrow.	Coke Removed by Conveyor.
Large coke	77·7 per cent.	74·0 per cent.
Domestic coke	14·2 ,,	15·0 ,,
Smithy coke	3·5 ,,	4·5 ,,
Breeze	4·6 ,,	6·5 ,,

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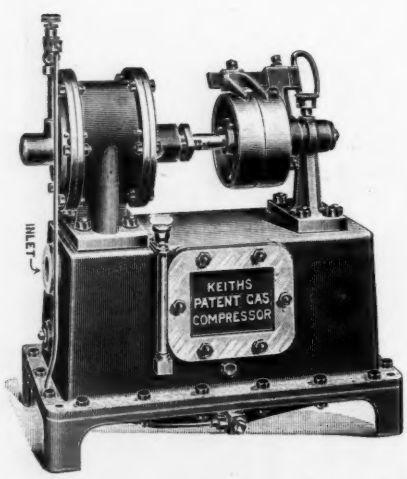

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Probably with barrow coke the proportion of breeze is not so apparent, since in the process of cart-filling a certain amount is picked up and goes with the large. The slightly increased quantity in the case of the conveyor may be due to several causes, as, for instance, the movement of the chain, the change of direction in the travel, or the occasional riding of the links on the coke. The latter is not likely to happen unless the bottom linings project or are uneven. It is interesting to note that in the improved West link the cross-bar is provided with a lip in order to lessen the possibility of coke getting under and lifting the chain. The breeze mischief is, however, first started by the mere drop of the coke from the retort into the barrow or on to the chain; and it is increased to a greater or less extent in subsequent stages wherever coke is allowed to fall. This is particularly the case where the fall is great and on to any hard surface, such as the iron of shoots and hoppers. Some tests have been made of coke which has travelled from the retorts and has been allowed to go through the screen into the hoppers.

The breaker is outside consideration; the jaws having been removed in view of the fact that sufficient domestic coke can be obtained by the simple process of screening. In case A, the coke fell straight from the end of the inclined conveyor into a steep iron shoot leading to the screen and thence dropped into the empty hoppers. In case B, the steep shoot was replaced by three others following successively, and arranged as far as possible to allow the coke to slide.

TABLE II.

	A.		B.
Large coke . . .	48·5 per cent.	..	55·5 per cent.
Domestic coke. .	32·2 ,,	..	29·9 ,,
Smithy coke . .	9·2 ,,	..	7·6 ,,
Breeze	10·1 ,,	..	7·0 ,,

These tests suggest that breeze production can be kept within certain limits.

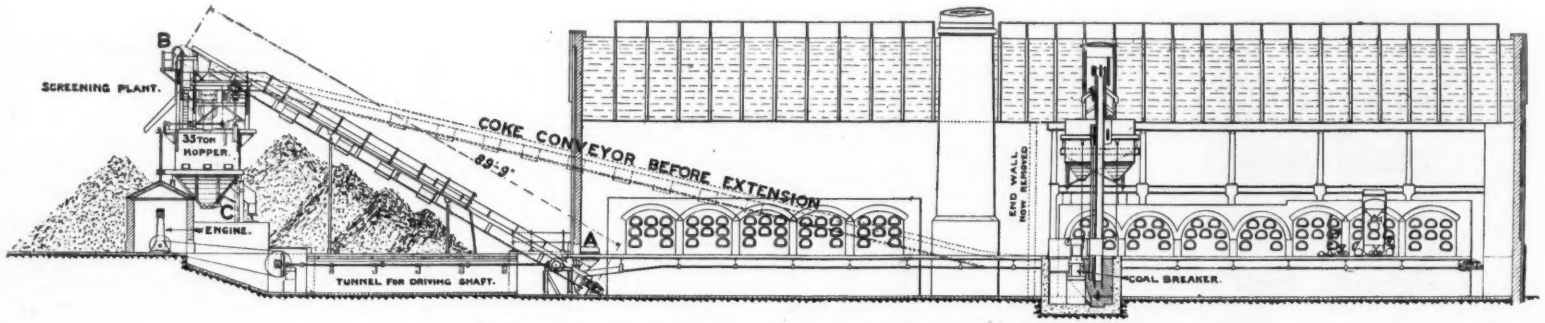


Fig. 1.—Longitudinal Section through the Retort-House and Coal-Stores.

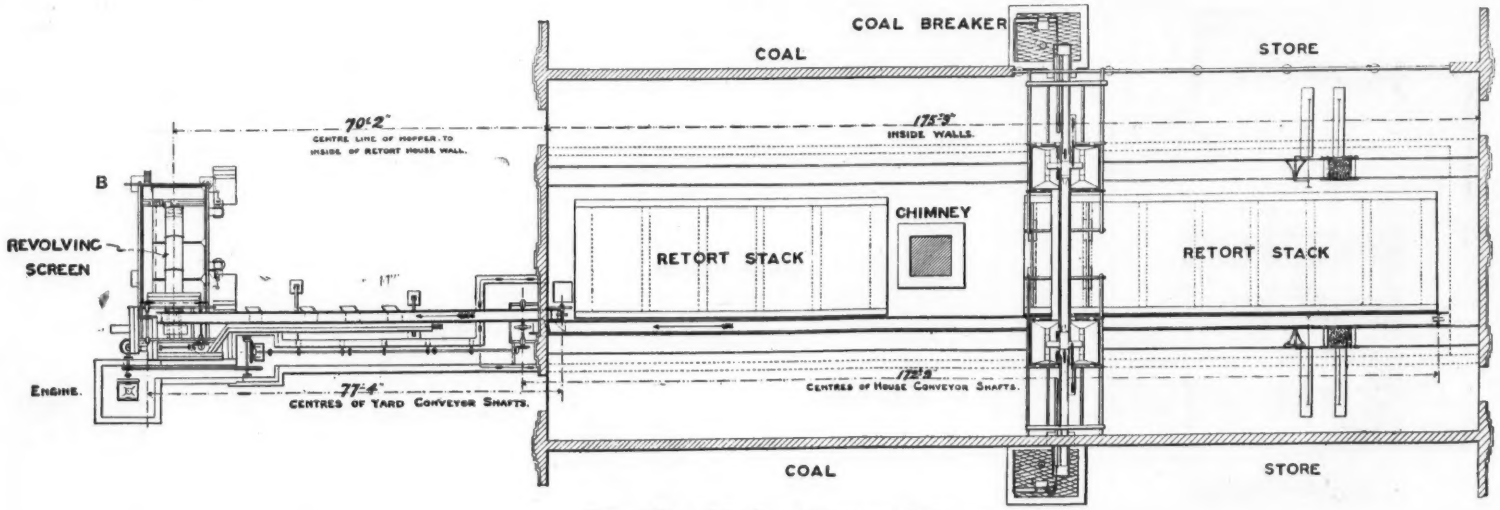


Fig. 2.—Plan of the Retort-House and Coal-Stores.

It will be understood that, in the ordinary way of working, not more than half the coke goes to the top and through the screen; the rest being deposited through the side shoots of the inclined conveyor on to the heaped coke below. Further, where coke is taken through the screens, the fall therefrom is broken by the coke already in the hoppers. While this may help in reducing the actual breeze percentage, it is not always easy to keep the whole of the smithy coke separate. Through enlargement of the screen apertures or through occasional spilling at the shoots, a certain proportion will find its way into the breeze hopper. As a second screening is expensive, the total quantity of so-called breeze to be dealt with is therefore somewhat greater than the above table indicates. For this reason the data in subsequent calculation is based upon the average of the breeze produced at the top of the inclined way (6·5 per cent.) and in the hopper (7 per cent.) *plus* (say) 1¼ per cent. for the admixture of smithy coke.

The breeze produced under separate coke-breaking conditions appears, according to data obtained from various sources, to reach as much as 6 to 7·5 per cent.; and the proportion due to this, added to what may be called the

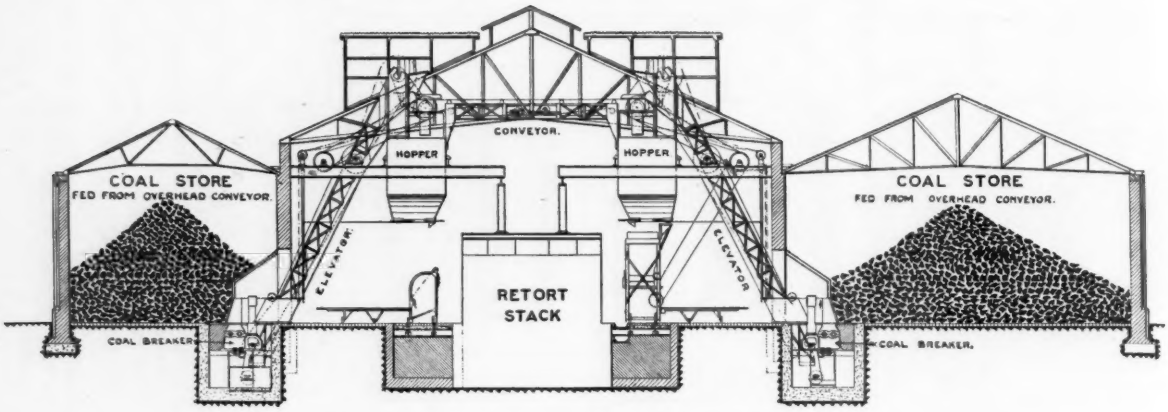


Fig. 3.—Cross Section of the Retort-House and Coal-Stores.

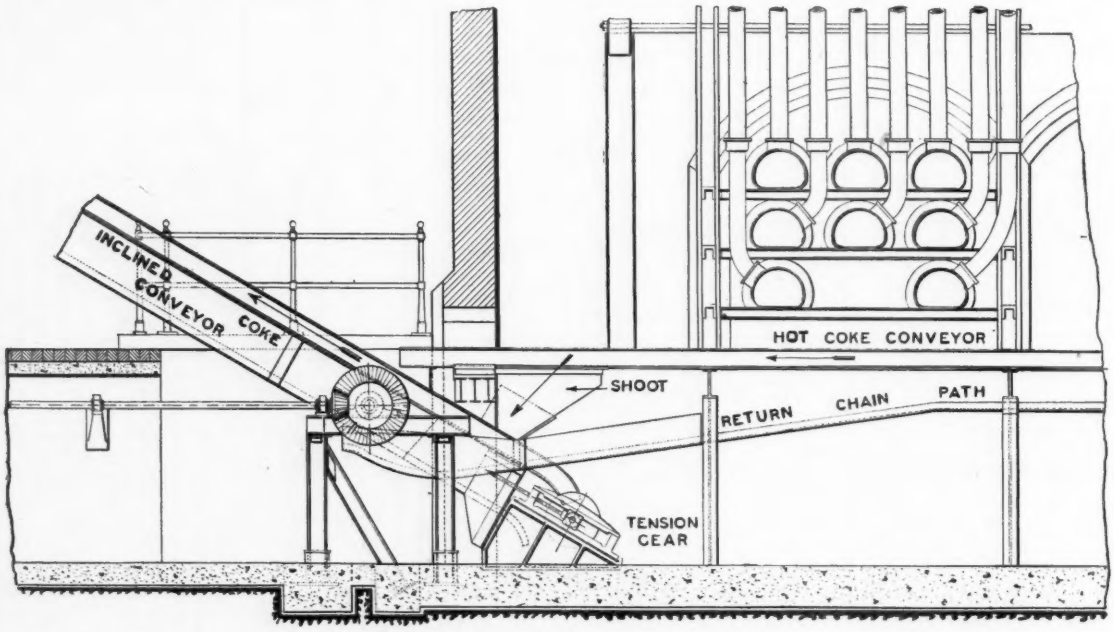


Fig. 4.—Side Elevation of the Coke Conveyor in the Retort-House.

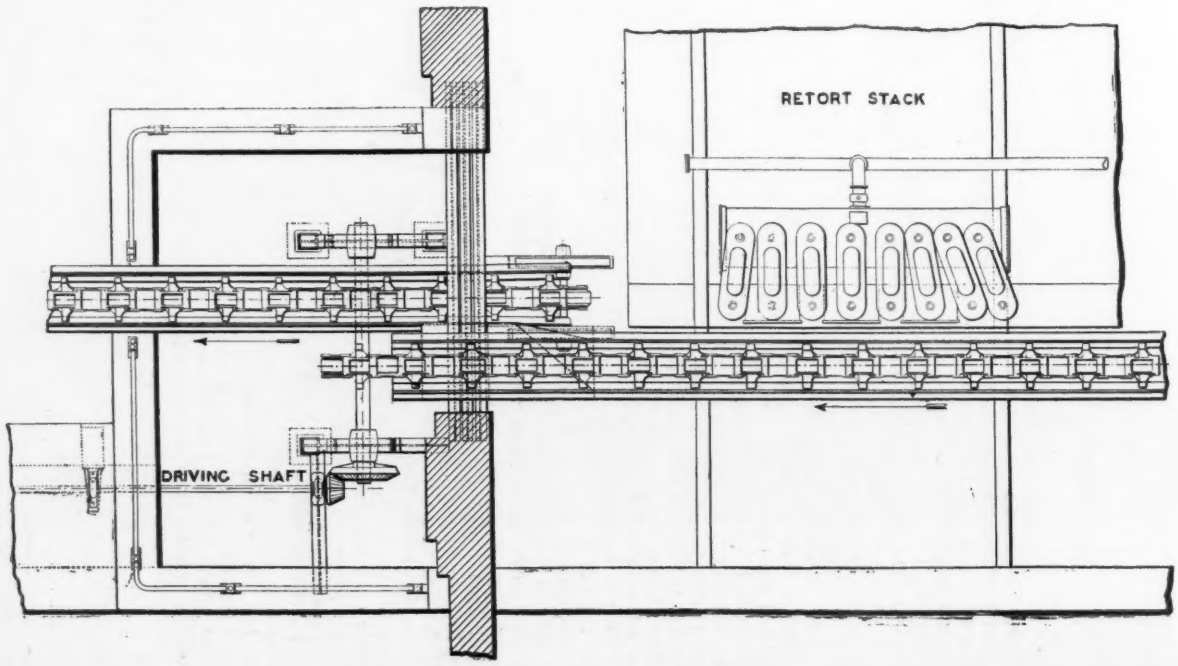


Fig. 5.—Plan of the Coke Conveyor in the Retort-House.

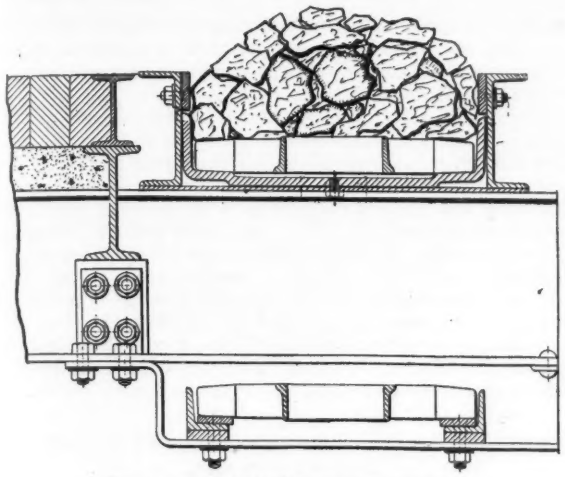


Fig. 6.—Cross Section of the Coke-Conveyor.

normal quantity in barrow coke, will yield an average percentage not far short of that obtained under conveyor conditions. It is not likely to be much less than 7 per cent. The breeze due to mere stacking is taken to be the same in each case, and does not therefore affect comparison. So far as breeze production is concerned, there does not therefore seem much to choose between the two methods. The excess is not great, but sufficiently so to cause trouble on some works from the point of view of disposal and pecuniary return. It is to an extent unavoidable where the breaking of coke is undertaken, and has to be faced. It was for this reason that a steam-engine in preference to a gas-engine was chosen to drive the Doncaster conveying plant. The effect on the boiler fuel account is, of course, appreciable; the breeze thus used being about $\frac{1}{8}$ cwt. per ton of coal carbonized.

From the data given, the quantity of breeze resulting from the handling of (say) 12,000 tons of coke—based on 22,000 tons of coal carbonized per annum—under the different conditions referred to may be compared as follows.

TABLE III.

Coke.	Percentage of Breeze Produced.	Tons of Breeze.	Excess Over (*a*).	Consequent Loss at 7s. 10d. per Ton.
				£
(*a*) Wheeled into the yard . . .	4·6	552	—	—
(*b*) Mechanically conveyed . .	6·5	780	228	89
(*c*) Wheeled, broken, and screened	7·0	840	288	113
(*d*) Mechanically conveyed and screened	8·0	960	408	160

[NOTE.—Coke is priced at 10s. 10d. per ton, and breeze at 3s.—difference, 7s. 10d.]

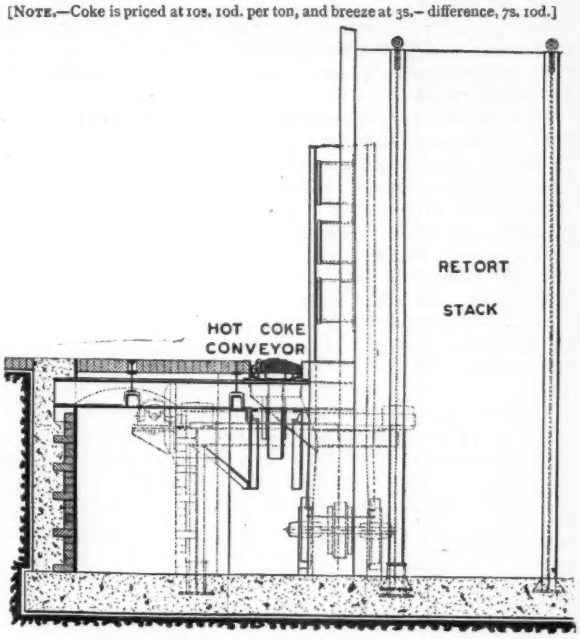
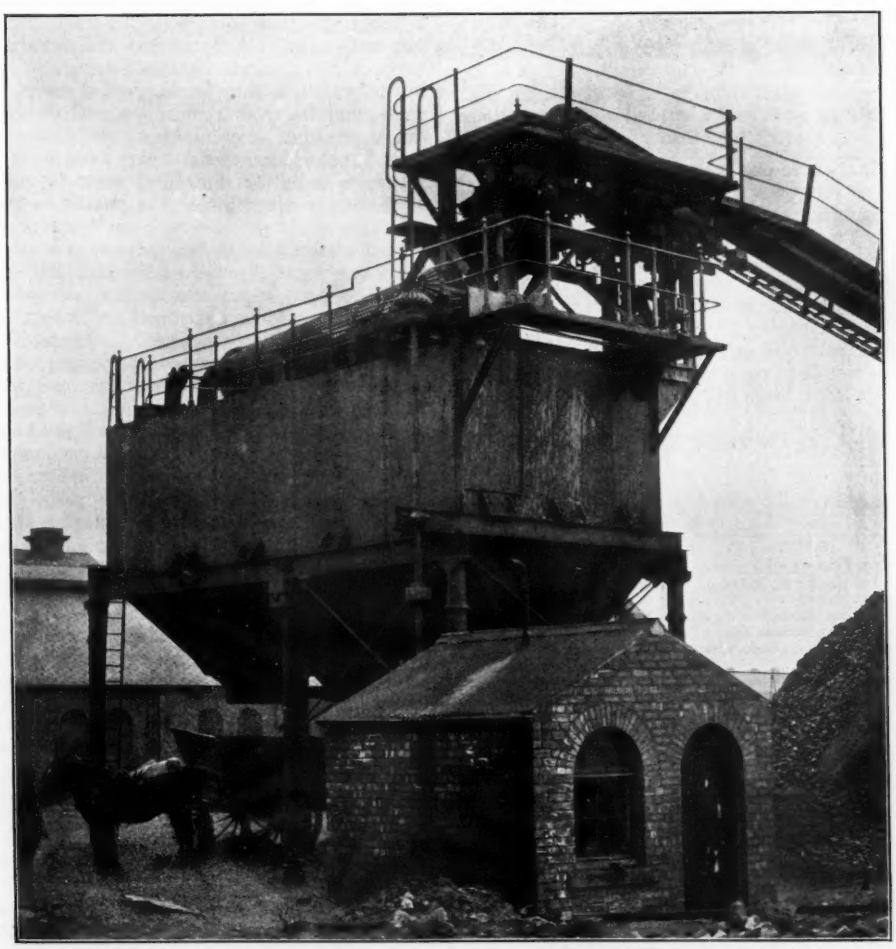


Fig. 7.—End Elevation of the Coke Conveyor in the Retort-House.



Head of the Coke Conveyor and Revolving Screen at the Doncaster Gas-Works.

Turning, now, to the matter of maintenance, the chief and inevitable expense (as with all conveyors) is caused by the wearing of the links, trough linings, and screen plates. The wear of the West link is usually on the under-side of the cross-bars of the block, and particularly where caught by the sprockets of the driving wheel. The bearing arms are protected by renewable hard cast-iron slippers, and they last remarkably well, easily outliving the trough linings and wearing strips. The joint pins and side links naturally come in for very great wear at points where pulling contact takes place. But these to some extent can be reversed, and their renewal is not expensive. The channel linings serve tolerably well; but it does not pay, from the point of view of breeze production, to allow them to wear irregularly—that is to say, to present inequalities of surface to the travelling chain.

The various considerations lead naturally to the important question of working costs, and the hazardous attempt of computation will be made for the different methods of coke handling, based, as far as possible, on actual data. The capital expenditure of the Doncaster plant, including foundations, subway, engine-house, &c., as shown on the Drawing No. 1, was £1816. Taking a plant installed for the sole purpose of delivering coke into the yard—that is, without hoppers and screens—the cost is estimated at £1500. The total expenditure for renewals, repairs, &c., works out at the rate of £219 per annum, of which £40 may be placed to the debit of the screening section.

TABLE IV.—*Costs per Ton of Coal Carbonized.*

(Basis, 22,000 Tons per Annum.)

Items.	Conveying and Screening.	Conveying Only.
	d.	d.
Interest and sinking fund on £1816 = £106.	1·16	—
,, ,, ,, £1300 = £76 .	—	0·83
Maintenance stores—£219.	2·39	—
,, ,, £179.	—	1·95
Conveyor attendants	1·75	1·75
Steam—¼ cwt. breeze at 3s. per ton . . .	0·60	(say) 0·50
Loss due to excess breeze—408 tons, £160.	1·74	—
* ,, ,, ,, ,, 228 tons, £89 .	—	0·97
	7·64	
Credit, Increased value of (say) 2000 tons of domestic and smithy coke at 1s. 3d.—£125	1·36	—
Total cost per ton of coal	6·28	6·00

* These items are included, although as a matter of fact no breeze is sold; all being used on the works.

The present plant could easily deal with 30 to 40 per cent. more coke; and as there is a growing demand for both gas and coke, the proportionate costs will naturally drop with the increasing output from the retort-house.

To get some appreciation of the comparative value of the above costs, it is necessary to add those for the removal of coke from the retort-house by barrows, and for the subsequent breaking and screening for the market. The figures in Table V. are in part estimated and based on Doncaster conditions. The cost of a power plant, covering engine and house, breaker, elevator, large hoppers, &c., would be about £500.

TABLE V.—*Costs Per Ton of Coal Carbonized.*

Items.	Wheeling, Breaking, and Screening.	Wheeling Only.
	d.	d.
Interest and sinking on £500—£29½ . . .	0·32	—
Renewals and repairs of plant—say £30 .	0·33	—
Barrows and repairs—say £50	0·55	0·55
Wheeling and part stacking (actual) . .	5·57	5·57
Yard help in stacking during winter, £52 .	0·56	0·56
Breaking and screening labour—2000 tons at 8d. = £66	0·72	—
*Loss due to excess breeze—288 tons, as per Table III. = £113	1·23	—
	9·28	
Credit— Increased value of 2000 tons of domestic and smithy coke . . .	1·36	—
Total cost per ton of coal carbonized .	7·92	6·78

* See note to Table IV.

Judged by the costs given in the above tables, it would seem that the gain as between barrows and conveyors used for removal purposes only is not very great; but the small profit shown, added to the important advantages indirectly accruing to retort-house working and to the men, would justify the use of the conveyor in comparatively smaller gas-works than Doncaster.

The results, when the effect on the disposal and sale of coke is taken into consideration, are much more decided. The difference in favour of the full conveying and screening plant, as compared with barrow wheeling and separate breaking and grading appliances, is as much as 1·64d. per ton of coal carbonized. The gain in the case of Doncaster is really greater, inasmuch as the loss indicated as due to depreciated coke in the shape of excess breeze is not fully incurred, since the latter is used on the works. The further fact is to be remembered—and this applies to other gas undertakings—that the supply of broken coke thus afforded has had the effect of withdrawing surplus coke from the outside market to be sold at full prices in the home districts.

Discussion on Dr. Lessing's, Mr. Bell's, and Mr. Watson's Papers.

Mr. CHARLES HUNT (London) said he had followed these papers with very great interest; and, with regard to the first two, he thought the most satisfactory feature of them was that they indicated the great progress which was being made in carbonizing arrangements. The days of the old costly and wasteful methods of carbonizing were likely to be numbered; but there were so many forms of carbonizing nowadays for gas managers to choose from, that it was rather an embarrassing matter to select one. Naturally, one turned to the Carbonization Committee for guidance in the matter—not necessarily as a recommendation of any particular method, but as an indication of the general principles to be followed. In this sense, he ventured to suggest that the report they had had presented was somewhat disappointing, as it indicated rather that they would have to depend in the future, as they had done in the past, upon individual effort rather than combined effort. Dr. Lessing's paper brought him back to the time, some fifteen years ago, when he was so much impressed with the progress then being made in Germany and Belgium with coke-recovery plant, that he suggested its application in this country as an adjunct to gas-works where there was a demand for metallurgical coke. He could not see any essential difference between the present chamber-setting and the coke-recovery ovens, which, as they knew, were horizontal chambers; the coal being dropped from above, and the coke being pushed out at one end. It was quite possible that, by putting the chamber on an incline, some little wear and tear of the setting was saved; but from what he had seen, then and since, of the operation of the pusher in the coke recovery ovens, he could not conceive anything more simple. With regard to the illuminating power—a matter into which he went very carefully before reading his paper in 1896—when he first began his inquiry into the subject, he said to the manager of a coke-works, "Why don't you use your gas for illuminating purposes?" He replied, "It is no good whatever." This put him (Mr. Hunt) on inquiry into the matter; and he had analyses of the gases taken, from which he discovered that the depreciation of the gas was entirely due to the method of working. They had an exhauster; and they overworked it. The consequence was that the gas was full of air. When the exhauster was properly controlled, and care was taken to keep the chamber perfectly sound, there was no difficulty whatever about the gas. It did not differ, practically, from the gas then being made in Birmingham, or from the analyses that he had taken of London gas. Therefore, he was rather surprised to hear that the gas made in these chambers was of low illuminating power—not that he attached any very great importance to the illuminating power, so long as the calorific value was kept up. Incidentally, all these new processes seemed to show that, not only were they able to maintain the comparatively low standard of the present day candles, but that the time was approaching when a new departure might be made, and they would go in for a much lower illuminating power, or the abolition of it altogether—maintaining, of course, the calorific value test. Mr. Bell's paper further indicated that there was life still in the horizontal retort. He was able, by heavy charges, to obtain very much of the result secured from the other methods. Of course, it was largely a question of the quality of the coke one desired to produce. One could not, with any system of horizontal retorts, obtain quite such a good coke as the President was

able to make with his chamber-setting at Norwich, or was made by coke-recovery ovens, or even by vertical retorts. There was only one point in Mr. Bell's figures which struck him, having had some little experience of Midland coals. He did not remember ever getting so much as 14 cwt. of coke out of any Midland coal; and if Mr. Bell had any secret about it, he should like him to impart it. He (Mr. Hunt) certainly had obtained it from Durham coal; but never from Midland coal. The Institution were much indebted to the authors for their papers, which would constitute a valuable addition to the proceedings.

Mr. Edward Allen (Liverpool) said the three papers indicated that the retort-house was still the centre of the greatest interest; and the old saying was as true as ever, that dividends were either made or lost in the retort-house. With respect to Dr. Lessing's paper, they were much indebted to him for the historical information he had given; and the subject of chamber retorts and coke-ovens was one which could not be left out of consideration when they realized how much was being done in Germany, on the Continent generally, and in America. But he felt more especially interested in Mr. Bell's paper, which he welcomed as valuable evidence in favour of the old-fashioned horizontal retort. It was true that some of the merits and advantages of the vertical retorts and coke-ovens could be enjoyed by those who used horizontals. If they went in for heavy charges and longer duration, they might obtain almost as good results as from coke-ovens; and, considering that their customers for coke were mostly those who desired it for domestic use, he thought they would obtain better results by means of horizontal retorts. The details of the installation had been very skilfully designed, as one would expect from Mr. Bell; and the working results were correspondingly successful. Some might be of opinion that hot-coke conveyors had great disadvantages, to some of which Mr. Watson had referred, such as wear and tear and damage to the coke; and there were those who thought that a telpherage system, or one in which the coke was carried, not pushed or dragged, was better than that of hot-coke conveyors. The analysis of the coke as given by Mr. Bell rather surprised him, because with regard to the small percentage of dust and fine breeze he was not quite in harmony with the figures given in Mr. Watson's paper. With reference to the retort stoking-machines, he must congratulate Mr. Bell on the actual results obtained with the De Brouwer machine, and the low working costs he was able to obtain; but he thought it was to Mr. Bell that the credit should be given. His ability, perseverance, great capacity for dealing with small details, not only in design but also in workmanship, and his untiring energy, had drawn from them for some years the greatest admiration. It was Mr. Bell, rather than the machine, who filled the eye. He believed that with other machines Mr. Bell could get as good, or possibly better, results. He did not wish to be misunderstood in any way; he thought the De Brouwer machine was a very excellent one. It was the best machine at a certain time. But there were now others; and he was of opinion that the result achieved by Mr. Bell with the machine he was using could be equalled if he had some other. With regard to the details given, he should like to emphasize the value of deep producers. He was quite sure that by using them Mr. Bell secured very good working; but he thought there was a little slip in the paper where he spoke of the ascension-pipes being on the charging side, because, looking at the photograph, they were on the discharging side.

Mr. Bell: It was a reference to what ought to be done.

Mr. Allen said there was no difficulty in pushing the coke from horizontal retorts as he had seen it practised. By getting a coke which was hard and large, they were able to command a better market. They also knew that coke must not be too large, if it was to be used satisfactorily in open fires or stoves; but still the consumer seemed to have a great prejudice in favour of large coke. As regards the cost of machines and wear and tear of retorts, their own experience with another machine quite carried out Mr. Bell's opinion as to the effect on the retorts. He attached great value to all these papers. As to Mr. Watson's paper, the great value he attached to it (apart from admiring his working at Doncaster) was that it would have the effect of making them all more concerned about preparing their coke for local markets, and doing away with the dumping process which had to be carried out under present conditions, but which interfered so much with neighbouring undertakings, and played into the hands of coke factors, who were delighted with the chance of getting cheap coke at one place to spoil the market in another—pocketing the difference.

Dr. H. G. Colman (London) said he found it extremely difficult to take part in this discussion, not because one did not know quite what to find to say, but because there was such a large amount of material covered by the papers (which he presumed included the report of the Carbonization Committee), that practically the whole of the wide subject of carbonization was open for discussion. As the President had pointed out in his address, at the present time all their ideas with regard to carbonization had been put into the melting pot, and were in a state of flux; and they were anxiously looking on waiting to see what new combinations were going to develop out of this melting-pot. They felt that whether they were looking at it from the point of view of understanding exactly, or getting as near to the truth as possible of what was going on in carbonization, or from the point of view of those who wanted to know what was the best plant to adopt for the future, they were all in a state of great perplexity. In view of these circumstances, he thought it would be advisable if he confined himself to one or two points which had been rather strongly in his mind in connection with this subject during the last year or eighteen months. In carbonization, they had to consider two main points. In the first place, they had, in order to drive out from the coal the maximum quantity of the volatile matter, to heat the coal finally to the highest temperature they could obtain. On the other hand, the volatile products, which were first formed by the distillation of coal, themselves, under the further action of heat, underwent decomposition, which, up to a certain point, was favourable to the gas maker, but after that became disadvantageous. They wanted to hit the happy mean, whereby in carbonizing they could obtain the first of these desired ends—the raising of the coke finally to a very high temperature—without at the same time subjecting the volatile products to over-cracking or to too great an extent of decomposition. This was really, in broad outline, the problem before them. Considering the second point a little further, they saw that the extent of decomposition of the volatile products must depend upon the manner in which the volatile products first formed, travelled onwards, and how they were subjected to heat in their travel. In the first place, they were affected if they passed through a large quantity of already formed red-hot coke. They were also affected by traversing a free space, where such was present above the coal in the retort; and beyond that there was a still further point at which an alteration in the character of the gases produced took place—a point perhaps less noticed than any other. This was the changes which took place in the hot gas after it left the retort itself, and before the point at which it was cooled to a temperature at which no such decomposition could take place—namely, in the ordinary horizontal or inclined retorts, in the ascension-pipe. No doubt, considerable changes in the character of the gas did take place in the ascension pipe, which were deleterious, not only by the formation of stopped pipes, but also with regard to the composition of the gas itself. In considering all these new developments—intermittent and continuous working of vertical retorts, and also large bulk carbonizing in coke-ovens up to 10 tons at a time—they must remember that there was no doubt variation in the manner in which the gas travelled through the coal or the coke after the first volatile products were produced and underwent decomposition; and what was true for one was not necessarily true for the other. On this account, they got considerable differences, according as the coal was carbonized either in small or in large bulk, or in horizontal or vertical retorts. Whereas up to some seven or eight years ago the general practice was to carbonize in relatively small charges, leaving a large amount of free space above the coal in the retort, the tendency now was all the other way; this being a direct result of the increase in knowledge which had come about through the newer development of the vertical retort. This was not an uncommon experience; it had occurred in almost every other industry. Any new development of an old-established method always, by the increase of knowledge it brought, put it into the power of those who worked the old method to operate it to better advantage. This had been well illustrated that day in the interesting paper by Mr. Bell; and it should be the endeavour of them all, as far as possible, to accumulate such information as would help in the ascertaining of the best manner of bringing about this optimum

decomposition of the volatile products, so as to obtain the maximum of gas of good calorific power—he supposed he must also say at present illuminating power, though he was in hopes that in a few years time they would no longer have to consider illuminating power, any more than their brethren in Germany had at the present time. In this question of the travel of the gases through the retorts, it seemed to him what they should aim at was to produce a gas which contained the maximum quantity of marsh gas or methane. This was, from a gas maker's point of view, even at the present time—and would be still more so when the illuminating power had no longer to be maintained—the constituent of far the greatest importance. It was on the question of how to obtain the maximum production of marsh gas, that their knowledge was at present distinctly limited. The newer processes for the manufacture of gas, either in intermittent or continuous vertical retorts, or in coke-ovens, did not yield the same amount of marsh gas as could be obtained from the same coals in horizontal retorts; and this, he must confess, came to him as a very great surprise. He fully anticipated that, in view of the fact that in vertical retorts, the volatile products which were formed did not get heated to so great an extent in their passage through the retort as they did in the horizontals, the percentage of marsh gas would be higher and that of hydrogen lower, because the marsh gas would not be so much broken up into free carbon and hydrogen as was the case with the horizontal retorts where there was a free space about the coal. But the analyses of the gas from practically all these sources, speaking generally (individual analyses might not quite agree), showed that the percentage of marsh gas was lower in the case of vertical retorts than it was from the same coal in horizontals, and the hydrogen was higher. This matter puzzled him very much last year when he had just completed his analyses of the gas in the Dessau vertical retorts; and he had had his preconceived notions upset. But just about twelve months ago, the explanation was given in that very room, in the lecture which they would all remember by Professor Bone, on the thermal decomposition of the hydrocarbons. Professor Bone then examined the decomposition of four gases—marsh gas, ethane, ethylene, and acetylene, and was very much puzzled fo a long time to account for the fact that in the decomposition of the three last-named gases he always got a very large quantity of methane produced. But the explanation Dr. Bone gave—and which he (the speaker) believed was correct—was that the first act of decomposition of these gases was the formation of hydrocarbons which could not exist under ordinary conditions, but which at high temperatures had a temporary existence. He could perhaps make this clearer by putting the formulæ on the blackboard. Taking C_2H_4, the first action of the heat was to give the hydrocarbons CH_3, CH_2, and CH—that was the simplest possible hydrocarbons. There was very much evidence in favour of the supposition that these could be formed at high temperatures; but Professor Bone pointed out that, in cases where such hydrocarbons were formed by thermal decomposition, there was always hydrogen present as well, which would combine with those hydrocarbons, and would in all cases give CH_4. Carrying this forward to what was taking place in a horizontal retort, where the gases passed through a free space, one had there, not merely ethylene and acetylene, on which Professor Bone experimented, but also large quantities of tar vapours, which, when subjected to heat, broke up. The ones he had in his mind more especially were classed together as the light oils of tar, which, in passing through the free space, were largely broken up, giving benzene, naphthalene, &c. In doing so, they would all undergo exactly the same decomposition that Professor Bone suggested in the case of ethylene, and would yield these bodies—the simple hydrocarbons capable only of transient existence—among their products. One always had under these conditions a very large amount of hydrogen present, so that in such a case also one would expect that by the decomposition of these tars at high temperatures the percentage of marsh gas would be increased; and, on the other hand, the percentage of hydrogen would be decreased, because the hydrogen yielding the marsh gas would give less than its own volume. If this explanation of Professor Bone, modified in the way he put it, were correct, one would expect that the gas from horizontal retorts, where the tars were over-cracked, would tend to increase the percentage of marsh gas and decrease the percentage of hydrogen; and this was exactly what happened. He (Dr. Colman) thought, therefore, that they might regard it as at any rate reasonably probable—he did not like to say anything more certain than this at present—that the breaking-up of the tars did considerably increase the percentage of marsh gas, and therefore yielded beneficial results. So that, in the case of carbonization, they had the formation of marsh gas affected by high temperature in two different ways—in the first place, owing to the cracking-up of the tars and the action he had just mentioned increasing the quantity and, on the other hand, by the gas passing over the crown of the retort there was the decomposition of the marsh gas and the formation of scurf. But in the horizontal retort, in this respect, the increased quantity of marsh gas formed by synthesis was greater than the amount decomposed by the hot walls of the retort, with the net result that the percentage of marsh gas was increased. This being so, how were they going to get the highest amount of marsh gas from the tar in the other systems? It seemed to him they could not expect, in the retort, to get the full amount of marsh gas under any of these systems which could be secured in horizontal retorts. If they were going to manufacture marsh gas from the tars in this manner, they must make the tar which was left richer in carbons and poorer in hydrogen, with the result that the tar would contain increasing quantities of free carbon and of naphthalene, and decreasing quantities of these light oils, which were necessary to effect anything like a complete removal of the naphthalene from the gas during condensation. So it seemed to him they must aim at the cracking-up of the tars which were produced in the vertical retorts and the coke-ovens, just to the extent—they had to find out what it was—where the tar gave up its maximum quantity of carbon to the gas, without at the same time increasing the amount of free carbon and of naphthalene to an abnormal extent. This was the problem; and it would require a great deal of work before they could successfully solve it. But if they bore this in mind, and worked at it, no doubt eventually they would obtain the full benefit of the gas manufactured from the tar. They did not want to make more tar than at present. In fact, if they could reduce the quantity it would be to their advantage; and if they decreased the amount of tar by converting a part of it into valuable gas, the advantages would be very great indeed.

Mr. J. P. Leather (Burnley) remarked that he did not wish to add much to the discussion of these three papers, as he considered that the greater portion of their value would consist in the record left on the "Transactions" of the great body of facts they contained. But he should like to ask a question, with a view to adding a little to the information given by Dr. Lessing. He stated the length of the chambers he had described, and the coal capacity; and it would be interesting to know what was the width of the chambers. The President in his address referred to the influence of the width of the chambers—that was, the distance the heat had to travel through the coal in carbonization; and it seemed to him an important point, which he regretted was not definitely dealt with in Dr. Lessing's paper.

Mr. A. T. Harris (Market Harborough) said there was one question which he should like to ask Mr. Bell. He understood from him that he had no difficulty in filling up his retorts by means of the coal-projector; and he took it that he filled them solid from end to end, leaving no space between the top of the coal and the top of the retort.

Mr. Bell: There is a space of from 2 to 3 inches.

Mr. Harris (continuing) said, with regard to the chambers described by Dr. Lessing, he took it that they were filled solid from end to end; and, if so, he should like to ask whether Dr. Lessing experienced any pressure at the opposite end of the chamber to which the gas was taken off. He asked because he found his experience with 45° retorts coincided exactly with what Dr. Colman had said. The passage of the gas was not always the same in every case. In working with Derbyshire coal, he found, no matter what was the rate at which the coal was projected into the retort, or the size of the coal, they got no pressure on the bottom mouthpiece. The gas was taken off at the upper end of the retort; and they had no difficulty at all in working. But immediately they got to the richer Yorkshire coal, they began to get trouble. This, however, was only due to two points practically—the question of temperature, and also the density of the coal in the retort. In working a bed of eight, the centre retort got hotter than the others, and in a seven-hour charge this retort towards the end got a considerable amount of pressure on the bottom mouthpiece; but

it did not occur in the others which were charged under exactly the same conditions. It seemed to him that in these chambers and in a full retort, they were practically governed by the temperature most suited to the class of coal used; and he was afraid that with a full horizontal retort, working with certain coal, there would be considerable difficulty with regard to the pressure, and also with regard to getting the coke out of the retort. If he had coal which expanded, he found with his 45° retorts that he had to push the whole of the coke out; and he was afraid that in horizontals there would be such an enormous quantity of power required that there would be considerable trouble with the retorts. He thought probably the little experience he had gained with the 45° inclined retorts would be of use to those who had also to consider the question of full retorts; and he should like to have Dr. Lessing's experience on the point he had named.

Mr. D. Irving (Bristol) said that, however much they might admire the various systems of carbonizing which had been brought before them, there was one point with regard to chamber-settings which he should like to emphasize. However successful they might be for carbonizing coal, it could never be regarded as a really scientific method of working, having regard to the intermittent nature of the charge. It seemed to him it could never be a correct system of working to pass into a chamber 5 or 6 tons of coal, and there let it distil for 24 hours. For a great portion of this time, the conditions of proper carbonization must be wrong; and therefore, whatever might be the future of chamber-settings or vertical retorts, he thought they must look to the continuous process as being most likely to produce the best and the most scientific results compared with either the chamber-setting or vertical retorts worked intermittently. Whatever doubts and perplexities they might have about the future of carbonization—either in a chamber or in vertical settings worked intermittently or continuously—it was a great pleasure to hear the very optimistic and cheerful account which was so generously brought before them by Mr. Bell. He was to be congratulated on the excellent results he had secured; and they were much indebted to him for the full details he had given, and the generous way in which everything was brought forward and tabulated. At Bristol, they prided themselves on being able to give their friends at Derby a lead with regard to working costs, and even with reference to the amount of coke sold per ton—which, after all, was the most important point in regard to coke. But after the results they had heard, he was afraid that at Bristol they would have to look to their laurels. With regard to the third paper, however admirable coke-conveyers were—and he believed they were admirable—for large works, they were scarcely suitable for small ones. In some of the larger gas undertakings, he did not know how it would be possible to secure the smooth working and admirable results which were being obtained, for instance, at Derby, without the aid of a hot-coke conveyor. But, of course, there were conveyors and conveyors; and a great deal depended on the design, and still more on the circumstances under which the conveyors might be called upon to do their work. From his own experience, he year by year grew more and more in favour of conveyors. They had at Bristol conveyors which had been in use for three years continuously; and though he could not give detailed figures, he was sure the result would be fully satisfactory as regarded economy.

Mr. John West (Manchester) wished to add his thanks to Dr. Lessing and Mr. Bell for the admirable papers they had produced. Perhaps no one present could appreciate Mr. Bell's work more than he (Mr. West) did, because he knew what time it must have taken to get out all the figures he had given; and he had put before them something they should all try to copy. It all went to show that, while there was a great deal of talk about verticals, horizontals with good machinery still "wanted killing." They knew from the "Journal of Gas Lighting" that he had again been paying attention to carbonization—it was not for the first time. He had applied himself to almost every new thing which had come forward in the shape of carbonization. All his life long, he had endeavoured to keep himself awake, and had watched every new process that came out. Two or three years ago, he made a study of vertical retorts; and then there came an opportunity to co-operate with certain others in trying to work out some of these problems. Fortunately, his friend, Mr. Samuel Glover, was able to convince his people at St. Helens that it would be a good thing to get some absolute facts and figures that might be compared with those of the old system of working; and, having been associated with Mr. Glover so long, he was called in to assist, and see if they could not collaborate, and work the matter out on definite lines. The Corporation of St. Helens said they would put up the plant if he and Mr. Glover would put up the retort-settings, and everything in connection with them. This was on certain stringent conditions—namely, that if he did not succeed in carrying out his part, he would get nothing for it. He had courage enough to undertake it; but it was not done without a considerable amount of thought. They made their plans, and devised methods whereby they could work out the theories which had been advanced, but which had never been thoroughly and practically tested. He devised certain pipes and bye-passes, so that they could shunt off from one side to the other, and see which was the best; and finally, they got to the present condition of working, some of the results of which had been published, and would no doubt receive due consideration. What they aimed at was to get a simple working apparatus to give the best possible results. The work was all done in the most suitable way; and at last they found that they could work best by gravitation—dispensing with all mechanism for feeding the retorts with coal—and by a new system of heating the retorts, whereby they heated them in chambers, so that they could regulate the temperature where they liked (the top, the bottom, the middle, or anywhere), and could alter the temperature at will, and throw the heat where they thought it was required. They succeeded very well in this respect. Then they introduced a method of abstracting the heat from the coke at the bottom, by passing the secondary air round the bottom, so as to get as much heat out of the setting as possible. In this way, the fuel account had been reduced to a very low figure—lower than anything he knew of in connection with vertical retorts. The coke extraction, too, was of a very simple character, and worked very well. What they desired was to get some comparative figures; and so they decided to test the work of the new verticals against the horizontals worked by a West manual machine, which distributed the coal in a very even layer, and gave off a large yield of gas per ton. Therefore, the comparison he had to work against was a tolerably severe one. They used the same coal in both tests, to see which produced the best results; and these results had been published. The difference was very great. They obtained a much larger yield of gas per ton from the verticals; they got the illuminating power; there was an increased quantity of tar; and a very superior coke, which was no doubt an important question. They took the coke out as large as some of the specimens on the table; and they were able to get 2s. 6d. per ton more for it. It was denser and better; and their customers preferred it to the coke produced in the other part of the works from the same coal. They had only been dealing with low-priced coal so far, because it paid the St. Helens people to buy the cheap coal in the district. But the question arose, "What would be the result if they used a superior kind of coal?" They proposed to try some Durham coal; and then gentlemen in the North and South would be able to compare their results with those produced by this system. A friend of his wrote him the other day saying that he had read all his reports, which appeared to be very good; but he was getting satisfactory results by the aid of West machinery, and he did not know how he could improve upon them with verticals. He could only say that if he (Mr. West) had the same coal that his friend used, he believed he could do much better with verticals. He had shown that they could get a very great improvement with common coal; and the only question was, "What advantages would be derived from using better coal?" He believed there would be considerable advantage there also. Again, with regard to the cost of working, his cost was very low; but they knew there were several gentlemen working at very low figures, which could be put side by side with what he had published. For instance, Beckton, the South Metropolitan works, Croydon, and the President himself and many others, could show figures which would compare favourably with the larger figures they gave, if they simply took the volume of gas. But then they were not being compared relatively. If he used similar coal, the question was, "What would be produced from that?" They were shortly going to try and determine this point. Dr. Colman was going to try some Durham coal; and they would then be able to judge of the differences in the systems. He could assure them there was a very wide field for the

development of these vertical retorts. With coal which on an average gave about 10,000 cubic feet per ton, he had got 12,300 cubic feet of gas, but not of a very high illuminating power—13·75 candles with a Carpenter burner. This would be good enough for Germany; but it was not good enough for England. They had everything under complete control, and they could regulate the machinery at will; so that, if they liked to leave the coal in a little longer, or work it a little faster, they could do either. There were no doubt elements in connection with it which lent themselves to the proper carbonization of coal. He knew of nothing against it; and the more he worked upon the system, the more he found out of its many advantages, though no doubt it would take a little time to develop them fully. They would be very pleased if anyone would come down and see the works, and criticize them. This question of the carbonization of coal was not a new one for him, especially in connection with trying to work out a continuous system. Forty years ago, he commenced trying to do this; and, in the year 1873, he patented a system for almost continuous working—using, of course, horizontal retorts—the coal being spread in the retorts, and the coke pushed out at the other end by the same apparatus. From that time onwards, there had been a gradual development, not only of his own machines, but of others; and he had had in his mind a system of continuous charging. He got a large volume of gas and high illuminating power using a thin layer of coal. They had now gone from the thin layer to the thick; but his method was having a very thin layer spread in the retort every half-hour or every hour, as required. As he said, they got a large volume with high illuminating power; but there were other difficulties which were objectionable.

Mr. A. F. P. Hayman (Berlin) said, in his opinion, the relation between the weight of coal to the heating surface of the chamber was not a favourable one in the system that had been described by Dr. Lessing. They had tried vertical chambers in Berlin; and they found they did not answer at all, because the amount of fuel was so much higher, and there was no advantage to set against this. The saving of labour by charging only once in 24 hours was considerably nullified by the irregular quality of the gas, which Dr. Lessing admitted to be a fact. He (the speaker) believed that in Hamburg the quality had been so irregular that complaints had been made by the Inspector of Public Lighting; and there was the difficulty of dealing with such large quantities of coke which had to be removed sufficiently quickly by machinery. In Munich and Hamburg, there was employed a large moveable tower, which delivered the coke after being quenched on to the trays. The quenching also led to the coke being much destroyed; and the lumps were not larger than was the case with ordinary gas coke. He believed that the enormous cost of this tower would almost frighten any gentleman present from introducing it—he thought it was as much as £3000. In his opinion, it was not yet proved that gas making in a retort was not the best system for gas-works practice. He thought it was proved that carbonization in an absolutely full vessel was the proper thing; but this vessel must be a retort, and not a chamber, because the former had a much greater heating surface.

Mr. H. Townsend (Wakefield) said he only proposed to address himself to Mr. Watson's paper, although he heartily appreciated the two others. Like a former speaker, he was a great believer in coke-conveyors, and he had had one in operation for nine years, which was still "going strong." But there was a good deal of difference between their conditions and Mr. Watson's, because they had inclined retorts with a stage floor, and Mr. Watson a horizontal house without a stage floor. Consequently, they got rather different results. Last year they dealt with all their coke by means of coke-conveyors; and they sold of the large coke 77·05 per cent., domestic coke 8·86 per cent., smith's breeze 6·67 per cent., and used in the works 7·42 per cent. They found that when they simply tumbled the coke from the retorts into the barrows it resulted in a considerable amount of breeze. If it was dropped into the barrows, the large coke was 70·47 per cent.; the domestic coke, 19·23 per cent.; smith's breeze, 6·15 per cent.; and dust, 4·15 per cent. This brought him to the point that the production of breeze was due to a very much larger extent to the dropping of the coke than to the carrying of it. He found that the dropping of the coke from the retort on to the conveyor had the result that they got 86·57 per cent. of large; 6·5 per cent. of domestic; 4·47 per cent. of smith's breeze; and 2·46 per cent. of dust. The retort-house conveyor, in taking the coke the whole length of the house, only diminished the large coke by 0·72 per cent., and only increased the domestic by 0·75 per cent., the breeze by 0·07 per cent., and it created no dust at all. Theirs was a De Brouwer conveyor, which was a different type from Mr. Watson's; but it showed that the actual working of the conveyor did not produce breeze or break the coke—it was the dropping which did this. Their conveyors consisted of a retort-house conveyor, an inclined conveyor, and a rotary screen. At the point where the coke dropped into the yard in the final conveyor, the breeze was not materially greater than in the retort-house conveyor. The great sinner in the production of breeze was the rotary screen, which reduced the large coke by no less than 10 per cent. Then when the coke was dropped finally into the yard, the large coke was again reduced by 11 per cent. So that he had come to the conclusion that the principle of the coke-conveyor was correct, if they could only improve the practical application of it, and do away with dropping as much as possible. Last year, when they had to extend their retort-house, they bore this point closely in mind; and, as the conveyor was at present, there was a great diminution in the amount of breeze. In fact, they could now hardly make enough for their own requirements.

Mr. Thomas Canning (Newport) said he greatly appreciated all the papers; but there was one big principle involved in both the first two, which was that they should increase as far as possible the value of the bye-products. Taking this as a broad principle, it would appear that the system so ably explained by Dr. Lessing aimed at the production of a very high quality of coke; and he had heard it hinted more than once that it was good for metallurgical purposes. Coming from a county on the other side of the Severn where metallurgy had its centre—especially near Swansea, where coke-ovens of the newest type were in full operation, and were being largely introduced—he would ask the members present whether they were likely to do much business in supplying gas coke for metallurgical purposes. Again, with regard to Dr. Lessing's paper, he should like to have some explanation of how, by the system of carbonization which he had described, he got such considerably higher calorific power. He said nothing about the illuminating power; but he wondered where the amount of benzol was to come from which would be necessary to make it good. Then, again, repairs and so on would, he thought, very much militate against the system. Mr. Bell had read an admirable paper; and he (the speaker) only wondered why he took off the pressure by an anti-dip, and then, apparently, put it on again. As regarded the question of coke conveying, he held a strong opinion. He did not say that those gentlemen who got good results from the hot-coke conveyor were not correct, nor did he wish to oppose them in any way; but he preferred the telpherage system, electrically driven, which lifted the coke, carried it to the spot required, and dropped it on the heap, and, above all, had the immense advantage that one could make up stocks with it.

Mr. H. W. Woodall (Bournemouth) said these papers were of the very highest order; and he did not think they had ever had contributions of greater interest to the gas industry. It seemed to him that the one thing they demonstrated was that, so far as carbonization was concerned their state was pretty much that of chaos. As Dr. Colman said, all their ideas had been put into the melting pot; and nobody knew what was to come out of it. With regard to vertical retorts and continuous carbonization, everyone must understand that it would be impossible for Mr. West and Mr. Glover to start on any process without bringing to bear on it ideas of the greatest value; and he was glad to hear that Mr. West thought so highly of it.

Mr. W. H. Y. Webber (London) said it had occurred to him, when listening to the remarks made by Dr. Colman and others, that the time had come when perhaps it would be an advantage to try to standardize some of their ideas of what was possible in the treatment of coal. In his studies of the subject, he had always been in the habit of looking with great respect at a certain table which was inserted in Mr. Hunt's paper read before the Institution of Civil Engineers in 1886, in which some very striking results were published on the carbonization of coal in ½ cwt. quantities in iron retorts. No doubt these figures would be in the minds of some members present. They ran up to about 13,000 or 14,000 cubic feet to the ton. But, as Mr. Hunt was at that time rather tied on the subject of sperm value,

he did not push his researches further than the point at which the sperm value appeared to be falling. It certainly had occurred to him, while listening to the remarks made that day, that it would be of considerable advantage, and might relieve the Carbonization Committee from the gentle reflection which Mr. Hunt put upon them that morning, if these experiments, or something like them, could be repeated with the larger views, and with the more exact methods (especially of estimating the illuminating power) of to-day. Possibly, in the course of the experiments, some little light might be thrown on such questions as that of the formation of methane, so ably touched upon by Dr. Colman.

Mr. E. A. HARMAN (Huddersfield) called attention to the fact that the cost per ton of coal could only have local importance, unless the rate of wages paid in the respective districts was also given.

Mr. J. H. BROWN (Nottingham) thought there was one omission from Dr. Lessing's description of the apparatus, which was of particular interest in connection with what they heard from Dr. Colman that morning as to the increased production of methane. In the Koppers ovens, he understood the flue was not taken above the height of the coal in the oven. The heating surface was kept below the top of the coal undergoing carbonization; and, by this means, they were able to increase the illuminating power of the gas very considerably. Of course, there was a certain amount of radiation; but the heating took place below the level of the coal.

Mr. H. E. COPP (West Bromwich) said a point which had struck him very forcibly in Dr. Lessing's paper was the fall of the illuminating power on continuing the charge. This seemed to him to indicate that the conditions of carbonization in the chambers were most improper, especially in view of the remarks of Dr. Colman, in which he pointed out that the task before the Carbonization Committee was to determine the point at which polymerization should cease. It seemed to him that this was a very important point. He had also found in the course of his modest investigations that illuminating power had some relationship to the temperature of the gases coming off; and the temperature was some measure of the extent of polymerization. He would suggest that, by some such means, the limit could be arrived at, and the temperature at which the breaking-down of the hydrocarbons must cease could be determined.

Mr. J. G. TOOMS (Waterford) suggested that the Carbonization Committee should not lose sight of the fact that there was a large percentage of members of the Institution for whom machinery of any kind was impossible, beyond an exhauster; and there were a number of other usually called small works where only modified machinery could be used. He thought the paper most likely to interest the bulk of the members, and to be of service to them, was Mr. Bell's. It showed how gas-works, however small, could improve their results by working on the lines and principles there enunciated. One question he should like to ask Mr. Bell, which no doubt he had considered, was why he went to the trouble and expense of raising his retort-house walls, when external producers would have accomplished his purpose just as satisfactorily. Working with external producers himself, without any regeneration, and using Durham unscreened gas coal, he was able to sell 10·8 cwt. of coke; there being 0·8 cwt. of coke breeze. He wondered, on looking at one of the tables where Mr. Bell pointed out the coke used per charge, when he had only 6 cwt. in his retort, what would be the result of carbonizing 10 cwt. in the same time as he carbonized 6 cwt., and whether he would not get practically the same result, and require less fuel for the same amount of work, with a consequent saving in the cost. Of course, he understood there might be difficulty about the coal.

Mr. W. H. MORGAN (Rhayader) said the question had been mooted now, for the first time as far as he remembered, of carbonizing coal scientifically. In his opinion, it had been done from the commencement in the most unscientific way possible; and it was a question whether they would ever be able to make gas in a really scientific way, because science had to give way to commercial expediency. His experience of manufacture of both hard and soft coke for fifty years was that, to make hard coke, the larger bulk of coal one got together the better; but to make gas, the less quantity of coal there was in bulk the better. Most of their difficulties were due to the large bulk of coal in the retort, which led to trouble because the gas could not get away. The smaller the quantity of coal the better, because they wanted to get as much coal as possible exposed to the same heat. He thought that Mr. West was nearer the scientific method of producing gas in his earlier efforts in 1873. It was a question whether they would ever be able to produce gas scientifically to pay, because there were so many things to look to. There was the sale price of the gas and the formation of bye-products as well. They were all interesting papers; but in his opinion they were working upon wrong lines, except Mr. West in his earlier experiments.

Mr. S. Y. SHOUBRIDGE (Lower Sydenham) remarked, on behalf of the Carbonization Committee, that after the tests which were made by Dr. Colman and Mr. Broadberry last year in vertical retorts, the Committee felt there was no reason to make any further tests this year, and also that the continuous retorts in this country were not in such a state that the Committee could give really definite results with regard to them. It would not be fair to the inventors of the two systems to present a final report on them; the same with regard to the carbonizing chambers. They had not reached that stage of development in which it was thought wise to incur the expense of making very costly tests—such as tests on the Continent necessarily must be; but they had by no means lost sight of the necessity of doing so at some future time. The Committee would bear in mind the suggestions made by Mr. Webber and Mr. Tooms, and see what could be done in the matter. He would call attention to the fact that the Committee had not unlimited means at their disposal. The funds for this work were very limited indeed, and they had to be careful of them. He should like to join in thanking Dr. Lessing for calling attention to the development in carbonizing chambers which had taken place on the Continent, and also to thank Mr. Bell very heartily for his most careful and accurate paper. It was extremely interesting to him, because he had put up a very similar, but somewhat larger, installation of retorts two or three years ago at the Lower Sydenham works with De Brouwer machinery with large coal charges and eight-hour periods; and he could confirm in almost every particular all that he had said about them. There was one item in which he could not confirm Mr. Bell absolutely, and that was the low cost of carbonizing wages; for while they were carbonizing for 9d. per ton, Mr. Bell succeeded in getting it down to 6d. Possibly the difference might be somewhat accounted for by the fact that their rate of wages was higher than in Derby, and that they had three shifts instead of two. With all his other conclusions, he was heartily in accord, except that he did not regard the arrangement of conveyor as quite the best. He thought that an enclosed conveyor, which held the steam in, tended a great deal more to corrosion than one which allowed the steam to escape; and it must to some extent block up the regenerator flues, and add to the cost of getting at the chain of the conveyor. He also desired to thank Mr. Watson for his paper.

Mr. T. S. LACEY (Nine Elms) asked whether Mr. Bell purified the gas for carbonic acid before the illuminating power was tested, and also whether as a rule he worked with eight-hour charges.

Mr. BELL said the gas was not purified for carbonic acid; and he used six, eight, ten, and twelve hour charges. During most of the time it was twelve hours.

Dr. ELLIOTT (New York) said he had listened with great interest to the explanation which Dr. Colman had given that morning, which was entirely on the line of work that he had done of a similar character.

The PRESIDENT said he must now call upon the readers of the papers to reply; and, as time was limited, he might inform them that they might send in further replies for inclusion in the "Proceedings." The same would apply to any members present who had anything of value to add to the discussion.

Dr. LESSING, after thanking the members for the patient hearing they had given him, said he was much obliged to Mr. Hunt for his criticism, because Mr. Hunt was the first man in this country to point out the possibilities of such a system, and he first investigated the working of recovery ovens in the Brymbo works in 1896. He had done very useful work in this direction. Mr. Allen had explained that his paper had more especially an historical value, which was quite true. It was merely brought forward with the intention of showing what was going on. He (the speaker) was not in a position to criticize the work—first of all, for lack of material; and, secondly, because he did not believe that it was possible to criticize properly a process which had only been going on for about two years, and on a large scale for something less than one year. For this reason, he could

not, from personal experience, answer certain questions which had been put. With regard to the width of the chamber, on which Mr. Leather asked a question, he did not like to load his paper with information which had been already published; and it was already stated in the "JOURNAL OF GAS LIGHTING" that in the Munich system the middle chamber was 2 feet wide, and the two outer ones 1 ft. 10 in. He had not got the dimensions of the other systems, because firms were rather reticent on matters of detail. The principle of having a wider centre chamber had been pointed out; and one speaker referred to a difficulty of this description in connection with the retorts—viz., that the centre retort in the setting got more heat than the two outer ones. This had been considered in the present case. As to the pressure in the chamber, it had been found useful in the newer installations to have a second ascension-pipe put in, which joined the short ascension-pipe at the top before leading into the hydraulic main, and which acted as a pressure equalizer. By this arrangement one could secure a pressure of about $\frac{1}{4}$ inch inside the chamber with the greatest ease; and the pressure did not rise much higher even during the period after charging. The difference with various coals—Derbyshire and Yorkshire—had been referred to, which opened up a very wide subject. Every coal would behave differently, because it would be in a different geological state, and its composition or structure might be different. Therefore one really had to consider every kind of coal under a different heading, especially as it would behave differently in consolidation and coke formation. These remarks had, therefore, to be taken generally, and must not be applied to any special kind of coal. Mr. Irving had referred to the question of intermittent and continuous working in the charging of chambers. He himself was rather in favour of continuous charging, believing it to be more scientific to maintain a certain state of carbonization at every point of the distillation vessel. On the other hand, one had to contend with enormous difficulties; and the possibility of carrying the problem into practice seemed to be rather far ahead. But it might be practicable, with recent experience of retorts and large distillation vessels, to combine them so as to form a useful instrument, as he had referred to in his concluding remarks. Mr. Hayman, whose criticisms were of very great value, referred to the comparison with vertical retorts, and to chambers tried at Berlin, which those members who had visited the Mariendorf works, or who had read the various descriptions given of them, knew were of a slightly different character. They were rather smaller, and more on the lines of a retort. This had been considered an advantage; and Mr. Hayman made a point of the small heating surface, by which presumably he meant the thinner layer of heated coke. The results were then not satisfactory. With these chambers, the width of each charge was rather larger; and therefore the conditions were different. The heating surface he referred to, in putting down the advantages of the chambers, was rather more the heating wall-surface; whereas Mr. Hayman had referred to the heated coke surface. This question of the width of the charge opened up the problem which Dr. Colman had so ably dealt with; and he thought his explanation was quite correct. He disclaimed from the outset any advocacy of this system of carbonization; his only purpose was to report progress, and show what had been done. On the other hand, he should like to discover for himself, and for the industry as a whole, what advantages and disadvantages there were. He believed that what he had termed the "flywheel" action of a large charge came somewhat near to what Dr. Colman asked for in ideal carbonization. They had a very large mass, which must not be assumed to be a mass of heated coke, because during the greater part of the period it would be coal, or partly decomposed coal; whereas heated coke would be present only in the final hours. If they had this large bulk, he thought it was possible—combining the actions, on the one hand of decomposing the volatile products released from the coal, and on the other hand of methane formation by combination with the hydrogen of the highly-heated hydrocarbon particles or molecules—that they would have a chance of striking the happy mean, and that they would get a compensating action in a large charge. In a small charge, it was very easily possible to run beyond the mark. All the different actions which went on in the retort overlapped each other; and they could not fix a certain point. But with a large charge there should be a possibility of doing this. One might, of course, happen to fix on the wrong point; but he believed, with longer experience and more knowledge of the occurrences in the chamber, one should be able to direct the process in a certain manner and by proper regulation of temperatures do it with a fair degree of success. Mr. Copp had asked a question with regard to the illuminating power; and it must be remembered that the Bunte curve (p. 834) did not represent an ordinary working curve. It was an experiment where the conditions were so selected as to be able to follow up the course accurately during the whole period. In an ordinary case, the curves would be rather different. He had some showing the work done by Dr. Sissingh in horizontal chambers, and they were much more like the curves obtained in working horizontal or full retorts. They were more on the level line, because by working in rotation one got the high illuminating period of one chamber following on to the other; and the gas to a certain extent mixed. The only drawback was that when charging only in daytime over a twelve-hour shift, the night shift would be producing rather different gas. It was, however, claimed that by this arrangement it was possible during the hours of highest consumption to get the best gas. Some, perhaps, would not like even this advantage, and would rather have a uniform gas throughout the 24 hours. With regard to the calorific power referred to by Mr. Canning, if methane only, or even principally, was produced, this would be quite sufficient to explain the calorific power; but it was not so much a question of heavy hydrocarbons or of hydrocarbons at all. There was a great difference between having gas of poor illuminating power, brought about by a lot of nitrogen drawn in from the flues, and one of low illuminating power being directly produced by the non-luminous hydrocarbons like methane. What had been mentioned with regard to the Koppers ovens explained a good deal. The flues did not extend to the height of the charge, and therefore it was possible to obtain a cooler space at the top of the charge.

The PRESIDENT said he ought to explain that they were under a great debt to Dr. Lessing for giving them this paper. He did not come as an advocate for these chambers; but he had given an account of carbonizing in chambers as he had seen it on his visits to the Continent, and he was kind enough to undertake this work at very short notice. They had a promise from Herr Schilling, of Munich, to do so; but nearly at the last moment he was prevented, and Dr. Lessing was good enough to take up the work, which they would all agree he had carried out in a very admirable way.

Mr. BELL said he was sure the meeting would not wish him to deal then with the various points raised; and he would take advantage of the offer to send in a written reply. He would simply thank the members for the kind way that his paper had been received. They must all be glad to know that the discussion had elicited a vast amount of information on the subject of carbonization. It was the work of Mr. Woodall, Professor Bone, and the President which had stirred up those who had horizontal retorts to see what they could do; and it was for each member to decide, in case of making any extensions, what system he would adopt

Mr. WATSON thanked the members for the kind consideration they had given his paper, and Mr. Townsend more especially for the corroboration he had given to his figures. He would only say further that he was sure they would all be glad to hear from any gentleman who had the telpher system in use some statement as to the results. There was no doubt a good deal in it; but some points they would like to hear about, and one of them was labour.

The following contribution to the discussion has been forwarded for publication by the Secretary of the Institution.

Mr. A. OWEN JONES (of the Staffordshire Chemical Works, Tunstall) writes: The Institution is to be congratulated on its choice of such valuable papers as we have had before us. The importance of the subject of these papers, and the prominent place held by the contributors, can only tend one way, and that is to increase our knowledge of such complex question as gas heating, carbonizing, and the best methods of transit of the hot coke. Dr. Lessing's paper prominently places before us the importance which bulk carbonization is making for itself as evidenced by the rapid developments on the Continent. The question as to whether horizontals, slopers, or vertical chambers are the most efficient, seems to me to be just in the same interesting position as that of the smaller gas-retort. Mr. Irving wishes the paper contained more data as to dimensions, &c. The Chairman's statements that only at the last minute Dr. Lessing was

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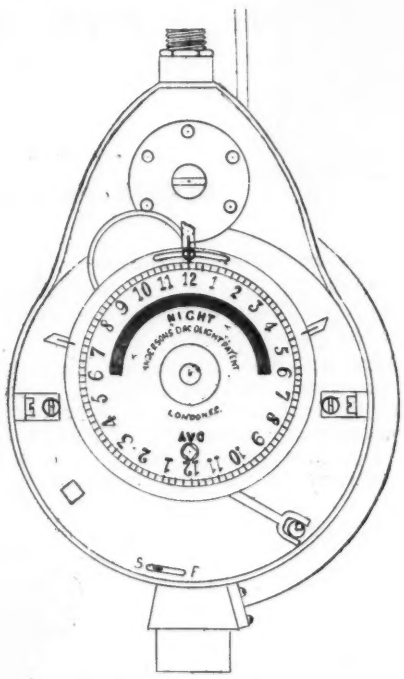

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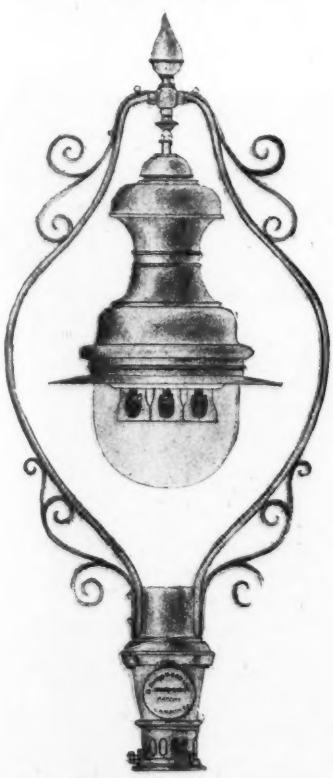

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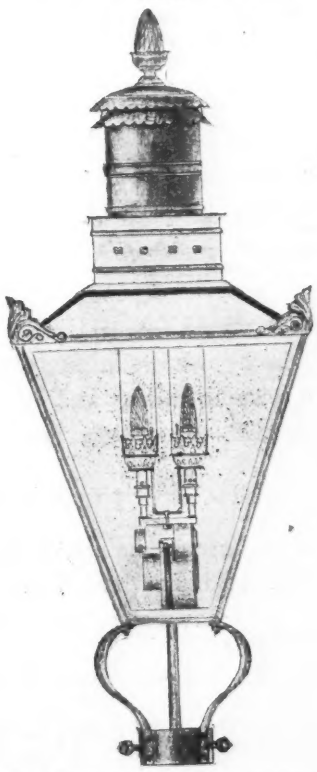

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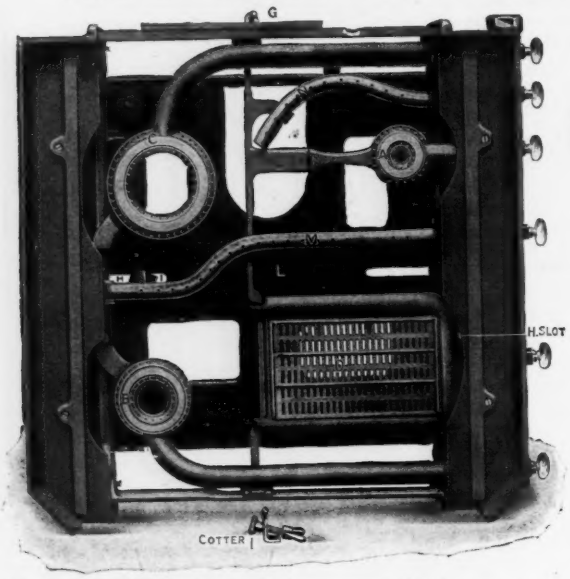

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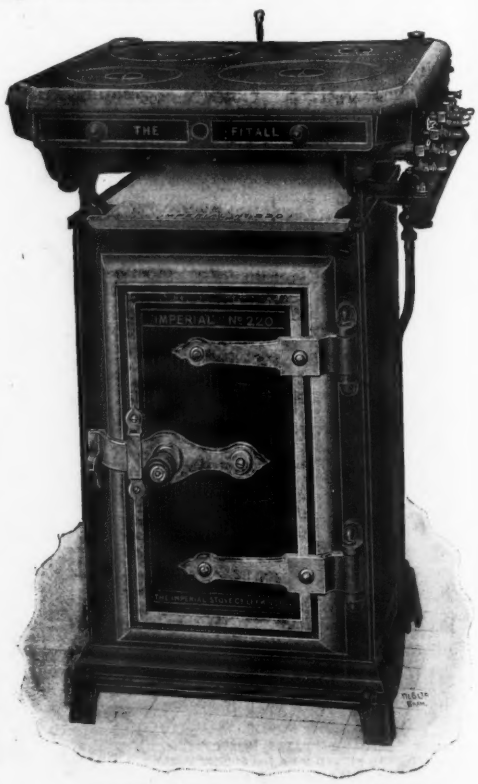

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asked to prepare his paper, no doubt, explains their absence; but I hope to be able to supply the information in a few days, as far as it applies to my vertical chamber. The theory of carbonizing in bulk as expressed by Dr. Lessing is an interesting one, and one which I have reason to believe is largely borne out by facts. Contraction of bulk is not sufficient in itself to explain why the coke leaves the walls; and the theory now put forward by Dr. Lessing is a very reasonable one. Dr. Colman's lucid explanation of the reasons of the altered conditions in the larger chambers resulting in the lowering of the percentages of marsh gas, is highly interesting. It occurred to me that the vertical oven with horizontal heating chambers would lend itself very well indeed to the conditions suggested by Dr. Colman for obtaining the critical point where the tar is cracked just to such an extent as to make the calorific value of the gas exactly what is desired. I mean that if the top flue were heated just to the point at which the tars were so cracked-up, the desired end could be attained. In my vertical oven, the arrangement of heating has for its object the means to a separate control of every portion of the chamber from the top to the bottom, to suit any conditions desired. Mr. Hayman does not seem impressed with the economy of coking in large bulk; but I think my experience in this respect is very convincing—that there is an enormous economy to be had. I understood Mr. Hayman to say that the relations of the heated surface to that of the coal in the vertical chamber and that of the vertical retort, were not to be compared; but I presume Mr. Hayman will admit that conditions that give tar practically identical with that obtained in the Dessau retorts with the same class of coal, are the conditions that tend to give the same quality of gas; and it may interest members to know that such conditions exist in my vertical chamber. I cannot see any reason whatever why gas of uniform quality in a properly-managed plant of large chambers cannot be obtained. The question of tight walls is very important, and can be attained. The lowering of the quality of the gas towards the end of the carbonizing period can be compensated by arranging that other chambers adjacent are producing gas of the best quality coinciding with this period. Therefore, with double the amount of gas made per square foot of ground covered, considerable reduction in working costs, better quality tar, possible increase in bye-products, and simplicity of arrangements for the controlling of heats (thus prolonging the life of the oven), are advantages which I hope will be considered of sufficient importance to merit the interest and investigation of members. Mr. Bell's paper interested me very much—especially where it showed how careful management in looking after details resulted in great economy; and the figures given by him are excellent results for the horizontal type of retorts.

ILLUMINATING EFFICIENCIES OF CARBON MONOXIDE AND HYDROGEN USED IN CONJUNCTION WITH INCANDESCENT MANTLES.

By ARTHUR FORSHAW, M.Sc.,

Institution Research Fellow in the Department of Fuel and Gas Engineering, University of Leeds.

Introduction.

The belief has recently become prevalent that the illuminating efficiency of a combustible gas used in conjunction with an incandescent mantle is proportional to its net calorific value. The basis of this belief seems to be the investigations carried out by Messrs. White, Russell, and Traver in the United States in 1901-2,* and, more recently, by M. Sainte-Claire Deville, of Paris, in 1907.† The experiments of Messrs. White, Russell, and Traver, which were embodied in a paper read before the Michigan Gas Association in 1902, consisted in a comparison between the net calorific values of various gases and their illuminating efficiencies in conjunction with the incandescent mantle when burnt in an ordinary atmospheric burner properly adjusted to give the maximum effect. They concluded:

1.—That no matter what gas was being used with the mantle (water gas, coal gas, or natural gas), the point of highest efficiency corresponded also with the point of maximum illumination.

2.—That the illuminating efficiency was proportional to the calorific value of the gas approximately in the proportion of 1 candle power cubic foot for every four calories increase in the net heating value.

An examination of the table of results published with their paper—the essential parts of which, together with an additional column showing the number of calories per candle per hour, which should be a constant, are reproduced below—shows that, whereas out of fifteen different gases, ten behaved in a manner consistent with the second of their conclusions, and two others approximately so, three gases—viz., water gas, carbon monoxide, and natural gas—were notable exceptions.

White, Russell, and Traver's Table.

Gas.	Net Calorific Value.	Candles per Cubic Foot.	Calories per Candle.
Water	60·24	5·53	10·89
Water and coal	108·9	17·5	6·22
Decarburized coal	130·9	21·86	5·99
Coal	144·3	25·4	5·68
Coal and carburetted water	147·86	28·48	5·19
Coal gas and benzolated coal	153·83	27·4	5·61
Benzolated coal	156·1	29·75	5·25
Carburetted water	169·6	32·9	5·15
Carbon monoxide	67·03	5·54	12·10
,, ,, and coal	112·11	20·69	5·42
Hydrogen	62·39	9·67	6·45
Pintsch	239·38	41·63	5·75
Natural	219·28	22·94	9·56
Coal and natural	162·96	25·43	6·41
Coal	140·55	25·60	5·49

M. Sainte-Claire Deville investigated a number of different composite gases, comprising "blue" water gas, coal gas, and various mixtures of the two, whose net calorific values varied between 76·8 and 208·8 calories per cubic foot (water gas to cannel gas). He employed an atmospheric burner specially constructed so that the relative proportions of air and gas in the mixture could be accurately measured. He found that the duty of a given gas (defined as candles per cubic foot per hour when the proportion of air admitted with the gas is so adjusted as to give the highest illuminating effect for the particular rate of gas consumption) invariably increased with the rate of consumption up to a certain maximum. Beyond this maximum, an increase in the rate of consumption caused no further increase in the duty, which, after remaining constant within a certain limited range of consumption, depending upon the size of the mantle, at length fell off considerably. Taking in each case this maximum duty as the proper basis of comparison with the different gaseous mixtures examined, he concluded that:

1.—The duty obtained for the expenditure of a given number of units of heat per hour remains constant within 15 per cent. throughout the whole range of illuminating gas, from neat water gas to neat cannel gas.

2.—That, therefore, it must be granted that the specific or normal illuminating duty in the incandescent burner is proportional to the calorific value of the gas.

Without questioning the accuracy of M. Sainte-Claire Deville's observations, it seems difficult to attach any physical meaning to the supposed simple connection between the calorific value of a gas and its illuminating efficiency, whatever view is taken of the cause of luminosity of the mantle. For if it be supposed that the mantle is a "light heat-engine," which in some way emits intense luminous radiations as the result of its being heated in the flame to a high temperature, the proposition that the luminous effect is proportional to the calorific value of the gas (which probably would bear some simple relation to the flame temperature) hardly seems consistent with what is known concerning the relationship between the total amount of radiation emitted by an incandescent solid and its temperature. Or, on the other hand, if it be argued that the luminosity of the mantle is connected with a supposed power of inducing surface combustion—a cause which may at least in part be operative—it must be admitted that its action in this respect will probably be selective with regard to the constituents of a given combustible mixture, and that any such selective action will depend chiefly on chemical factors, and will have no necessary, or even obvious, connection with the total calorific value of the gas.

It may be observed that, with few exceptions, the comparisons so far made between the illuminating values of various gases and their calorific powers have had reference

* See "JOURNAL," Vol. LXXVII., p. 879; Vol. LXXIX., p. 892; and Vol. LXXX., p. 562.

† *Ibid.*, Vol. C., pp. 22, 173.

to more or less complex mixtures of gases, and that the results of such experiments as have been made with single gases, or with mixtures of two gases, are precisely those which do not conform to the conclusions drawn from the more complex cases. This is particularly so with regard to the results obtained by the American investigators. When, therefore, it was suggested to the author, at the time of his appointment to the Gas Fellowship at the University of Leeds, that he should, as part of his work, investigate the question *de novo* from a fundamental standpoint, it seemed desirable that a careful series of comparative experiments should be first of all made with one or two gases in a state of purity; and for this purpose hydrogen and carbon monoxide seemed to possess qualities which eminently fitted them for such a comparison.

In the first place, these two gases are similar in having nearly the same net calorific values—namely, carbon monoxide = 85·9 kg. cent. units, and hydrogen = 72·8 kg. cent. units per cubic foot at 0° C. and 760 mm.—and also in requiring exactly the same proportion of oxygen (or air) for their complete combustion. But here their similarity ends. They differ in two important respects—namely, in density and in what may be termed, for want of a better phrase, their "combustion intensities." The density of carbon monoxide is fourteen times that of hydrogen (and therefore their relative diffusibilities are as 1 is to 3·74); and not only is the rate of combustion of hydrogen known to be very much higher than that of carbon monoxide, but also their rates are unequally accelerated by the influence of hot surfaces.

It was therefore decided to make a systematic investigation of the mantle efficiencies of these two gases, and the conditions requisite for the attainment of the maximum illumination from each, with a view to determining whether —with two single gases having nearly the same calorific values, but exhibiting considerable differences in the character of their flames and their modes of combustion—the supposed dependence of illuminating effect upon the calorific values could be verified.

Experimental.

A.—*Preparation and Storage of the Gases.*—At the outset of the investigation, it was necessary to instal a photometric equipment specially adapted for the investigation of single gases; and one of the first requirements was an arrangement for the preparation and storage of the two gases in quantities sufficiently large for continuous and satisfactory working. The hydrogen was prepared by the action of pure dilute sulphuric acid upon the "Crescent" zinc as now manufactured by an electrolytic process by Brunner, Mond, and Co. This brand of zinc has a high degree of purity. It is guaranteed "arsenic free," and contains only traces of carbon, but no sulphur. It is therefore well adapted for the preparation of hydrogen on a large scale. The gas as it was evolved from the generating apparatus was passed through a series of large wash-bottles containing a hot alkaline solution of potassium permanganate, and was then collected over water in a 10 cubic feet gasholder. The gas usually contained between 0·4 and 1·35 (average 0·85) per cent. of methane, and had an average net calorific value of 73·9 kg. cent. units per cubic foot, as compared with 72·8 for pure hydrogen. As a convenient means of storage, the gas was compressed into iron cylinders at 200 atmospheres pressure; the largest cylinders employed having a capacity of 60 cubic feet of gas at this pressure. In the photometer room, the cylinders of compressed gas were connected with two automatic reducing valves in series, whereby the pressure was reduced down to nearly atmospheric pressure at the point of delivery to the meters leading to the special burners on the photometer bench.

Owing to the exceedingly poisonous character of carbon monoxide, it was not considered safe to store it under high pressure; and, therefore, other arrangements had to be adopted. The gas was generated by dropping 90 per cent. formic acid into hot concentrated sulphuric acid contained in a large round-bottomed flask. To ensure its freedom from acidic impurities, it was passed first of all through a bottle containing a strong solution of caustic soda, and afterwards up a coke-tower, down which a stream of the same liquid was kept running. The gas was finally collected in a 5-feet holder over water. Analysis showed that it contained, on an average, between 97 and 98 per cent. of carbon monoxide, and had a calorific value of 83·5 kg. cent. units, per cubic foot, as compared with 85·9 for the chemically pure gas.

B.—*Photometric Arrangements.*—The photometer bench was of the open-bar type, 12 feet in length, and graduated into centimetres. It was provided with suitable wheeled carriers for the photometer head and for the special burner or burners used during the investigation. The standard of comparison was a Harcourt 10-candle pentane lamp, which was fixed to a sliding table resting on the photometer bar. In accordance with the advice of Mr. Charles Carpenter, the pentane standard and the special burner used for the tests were fixed at a distance of 150 centimetres apart for all illuminating powers up to 100 candles. Above this limit, it was found necessary to increase the distance to 200 centimetres. The actual tests were always made with the aid of the Simmance-Abady "Flicker" photometer, which was very kindly presented to the department by Messrs. Alexander Wright and Co.

Since it was considered desirable to measure not only the rate of consumption of the gas under investigation, but also the proportion of air mixed with it at the burner nipple, arrangements were made for using compressed air from storage cylinders of 60 cubic feet capacity at 200 atmospheres. This air was compressed in the laboratory, and the cylinders were afterwards connected with the meters on the photometer bench through two reducing valves similar to those used in the case of compressed hydrogen. Both gas and air supplies were passed through suitable meters and governors before delivery to the burners on the photometric bar, and a King's gauge on the gas supply showed the pressure at the injector nipple.

C.—*Construction of the Burner.*—The burner was in its essential parts a copy of M. Sainte-Claire Deville's burner. It is illustrated in fig. 1. The gas enters by the bottom pipe, and, passing upwards, arrives at the injector nipple *a*, from which it issues into the mixing-chamber *b*. For carbon monoxide, it is necessary to use a nipple with a larger aperture than for hydrogen. The nipple is therefore detachable, and the air-chamber can be unscrewed to give access to it. In the top of the mixing-chamber is placed the ascension-pipe *c*—provided with a screw-thread, by means of which its height above the nipple can be adjusted. The upper part *d* of the ascension-pipe is of small diameter (¼ inch), to increase the velocity of the upward flowing mixture of gas and air. Finally, the burner-head *e*, containing gauze-rings, fits the end of *d*. The mantle is held in position by an outside support attached to *d*, and not shown in the illustration. For the making and subsequent modification of the burner, the author is indebted to Messrs. George Bray and Co., who kindly gave him the advantage of their experience. The burner heads are of two sizes, No. 0 and No. 2, which were designed to fit the Welsbach mantles No. 0 (50 mm. long by 14 mm. diameter) and No. 2 (75 mm. long by 25 mm. diameter at the bottom). The Welsbach Company kindly supplied several dozens of each size of mantle—all made from the same batch of material.

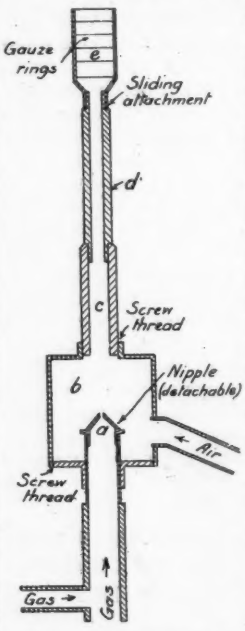


Fig. 1.—Burner with Head No. 2.

D.—*Results of Experiments.*—Before proceeding to the results of experiments, it is necessary to make several definitions and explanations of terms used in the tabulated results.

H_2 = cubic feet of hydrogen per hour measured at 0° C. and 760 mm.

CO = cubic feet carbon monoxide per hour measured at 0° C. and 760 mm.

Air = cubic feet air per hour measured at 0° C. and 760 mm.

C.P. = candle power in sperm candles.

$\frac{\text{C.P.}}{\text{Gas}}$ = candles per cubic foot of gas per hour = duty.

$\frac{\text{Air}}{\text{Gas.}}$ = cubic feet of air per cubic foot of gas.

$\frac{\text{CV} \times \text{Gas}}{\text{C.P.}}$ = calories per candle per hour.

All gas measurements are reduced to dry gas at 0° C. and 760 mm.

The first experiments were made with hydrogen, using a No. 2 mantle. It was soon found, however, that the burner-head, as originally designed, was not suitable to the combustion of a mixture of hydrogen with more than about one-fifth of the air necessary for complete combustion. As soon as the ratio of air to gas in the mixture issuing at the burner-head reached the limit of 0·52, back-firing occurred. The approach of this limit was always heralded by a peculiar singing noise in the burner-head; and in these conditions the addition of even a small amount of air caused the mixture to explode down the tube of the burner with considerable violence. Within the narrow limits of variation of the proportion of air to gas imposed by the construction of the burner, it was found:

1.—That the duty obtained with each particular rate of consumption of hydrogen increased with the amount of admixed air up to the point at which back-firing occurred.

2.—That the duty obtainable regularly decreased with the rate of hydrogen consumption.

This is clearly shown in Table I., as follows :—

TABLE I.

H_2.	$\frac{\text{C.P.}}{H_2}$ No Air.	$\frac{\text{C.P.}}{H_2}$ Most Air.	$\frac{\text{Air.}}{H_2}$
2·35	6 8	7·9	·52
2·87	5·64	7·02	·48
3·32	4·87	6·32	·45
3·62	4·72	6·19	·43
3·95	4·0	5·39	·39
4·80	—	4·94	·35
4·99	—	5·04	·26
5·13	2·91	4·5	·43
5·65	—	3·77	·37

In further experiments on hydrogen with this burner, it was found that the best duty was obtained when the ascension-pipe was fixed as high as possible above the nipple—due, no doubt, to better admixing of the gas and air before it reached the burner-head. It was also remarked that whereas with low consumptions the mantle was brilliantly illuminated at its base but rather poorly on the higher portions of its surface, with high rates of consumption the illumination of the base fell off considerably, while that of the middle and upper portions was greatly increased. This circumstance is doubtless to be ascribed to the squat and bulky shape of a badly-aërated hydrogen flame, which is ill-adapted to any ordinary form or size of mantle. It was therefore decided to modify the construction of the head of the burner in order to allow of a much better aëration of the hydrogen flame without its striking-back. This entailed several months' experimental work.

At this stage of the investigation, it was becoming increasingly evident that the distribution of illumination over the surface of a mantle was vastly different in the case of the two gases when burnt under similar conditions with a badly-aërated flame. Arrangements were therefore made to compare the distributions of illumination over the mantle in the two cases. The method adopted was to estimate the intensity of the illumination of small areas over the whole of the mantle by means of a Féry optical pyrometer, which gives what is essentially a photometric measure of the luminous radiation in terms of an arbitrary temperature scale attached to the instrument.

With regard to the experiments under consideration, the illuminations of the various parts of the mantle are expressed in terms of the readings on the arbitrary temperature scale of the instrument; but it must be understood that these temperatures would only be approximately correct if a mantle corresponded to the ideal "black" body. For the purpose of this paper, their readings may be taken as relative measures of illumination according to a particularly arbitrary scale; and the various diagrams relating to these experiments must be interpreted accordingly. In carrying out the tests, portions of the mantle were screened off from the pyrometer by means of a sheet of metal having a rectangular hole 12·5 mm. wide by 5 mm. high. The screen was placed about 2 inches in front of the mantle, and the optical pyrometer was fixed at a distance of about 6 feet on the other side of the screen, in correct alignment with the slit. The burner carrying the mantle was mounted on a carriage provided with a rack-and-pinion arrangement, whereby successive areas of the mantle could be brought opposite the slit, and the distribution of illumination over the whole surface of the mantle from top to bottom could be mapped out.

ILLUMINATION CURVES FOR CARBON MONOXIDE AND HYDROGEN.

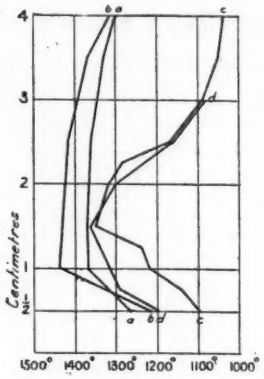


Diagram I.—Comparison of Illumination CO (*a b*) and H_2 (*c d*) for same amounts burning.

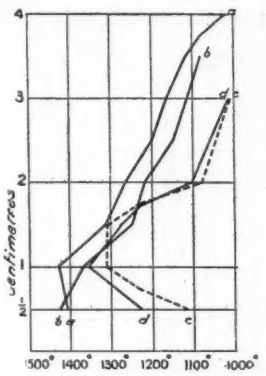


Diagram Ia —Typical Curves of Illumination for CO (*a b*) and H_2 (*c d*).

The character of results obtained is shown in the curves in Diagrams I and Ia.

In these diagrams the vertical heights above the burner head of the centre of the small areas examined on the mantle surface are plotted as ordinates against readings on the arbitrary scale of illumination as abscissae.*

The actual figures for consumption of gas and air for these curves are shown in Tables II. and IIa., and were obtained with the small No. o size mantle.

TABLE II.

Curve.	Gas.	Air.	C.P.	$\frac{\text{C.P.}}{\text{Gas.}}$	$\frac{\text{Air.}}{\text{Gas.}}$
a	1·88 CO	*Nil*	9·48	5·03	..
b	1 88 CO	0·66	15·15	8·04	·35
c	1·86 H_2	*Nil*	3·77	2·03	..
d	1·86 H_2	0·74	5·18	2·78	·40

TABLE IIa.

Curve.	Gas.	Air.	C.P.	$\frac{\text{C P.}}{\text{Gas.}}$	$\frac{\text{Air.}}{\text{Gas.}}$
a	1·22 CO	*Nil*	10·75	8·79	..
b	1·22 CO	0·52	7·45	6·09	·42
c	1·30 H_2	*Nil*	2·9	2·23	..
d	1·30 H_2	0·56	3·94	3·03	·43

The figures in the above tables refer to similar rates of consumption of hydrogen and carbon monoxide, for the same mantle and burner, with flames almost equally aërated. The total light afforded is, however, very different in the two gases; nor is the reason far to seek. A glance at the curves shows that the distribution of illumination is quite different; for whereas the illumination caused by hydrogen is mainly at the bottom of the mantle and falls away very rapidly on the upper half, owing to the squat and bulky shape of the flame, in the case of carbon monoxide the illumination is very little different on the upper and lower halves of the mantle—the falling off being quite gradual, and pointing to an upright tapering flame for this gas.

With the addition of a small amount of air to the hydrogen flame, the illumination of the bottom of the mantle was immediately increased, while that of the upper portions faded. The flame is smaller and more concentrated. This is shown in Diagram I, curves *c* and *d*, and in Diagram Ia, curves *c*

* As far as the author is aware, diagrams have not before been used for this purpose. As indicators of the distribution of illumination over the mantle surface, they may be compared to the "indicator diagrams" which show the distribution of power over the stroke in an engine cylinder.

and *d*. In the case of the carbon monoxide flame, the addition of air increased the illumination all over the mantle surface (curves *a* and *b*, Diagram I and IA). As the result of increased aëration, the flame shrank and fitted the mantle better. Evidently this was the best possible fit with this rate of consumption of carbon monoxide; for on adding more air the candle power dropped, and the illumination of the upper half of the mantle became less and less. This is shown graphically in Diagram II. Here, in curves *c* and *d*, the bottom of the mantle only is appreciably illuminated; the illumination of the top falling away in a very marked

ILLUMINATION CURVES FOR CARBON MONOXIDE.

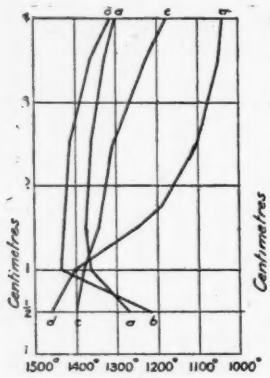


Diagram II.

a. Too little air.
b. Correct amount of air.
c. Too much air.
d. High excess of air.

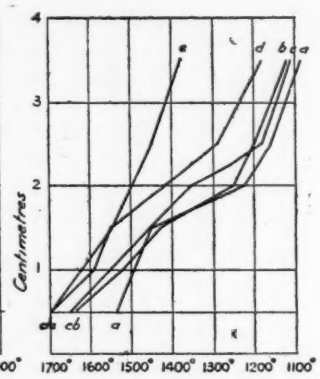


Diagram III.

a. Too little air.
b. Too much air.
c. Correct amount of air.
d. Effect of more gas and air on *b*.
e. ,, ,, ,, *d*.

degree. The rates of consumption corresponding to these curves are shown in Table III.

TABLE III.

Curve.	CO.	Air.	C.P.	$\frac{C.P.}{CO.}$	$\frac{Air.}{CO.}$
a	1·88	—	9·48	5·03	—
b	1·88	0·66	15·15	8·04	·35
c	1·88	0·94	14·7	7·80	·50
d	1·88	1·69	7 87	4·18	·90

It may be noted here that with these low rates of consumption the burner was not working at its best; and, consequently, the values for the duties are low as compared with those shown in the next table.

TABLE IV.

Curve.	CO.	Air.	C.P.	$\frac{C.P.}{CO.}$	$\frac{Air}{CO.}$
a	2·05	2·37	18·47	9·01	1·16
b	2·05	3·19	23·75	11·64	1·56
c	2·05	3·91	20·15	9·83	1·91
d	2·59	3·78	36·6	14·10	1·46
—	2·59	4·05	40·5	15·61	1·56
e	3·09	5·00	60·0	19·41	1·62
—	3·09	6·18	43·8	14·17	2·0

The illumination curves for this table are shown in Diagram III.

Curves *a*, *c*, and *b* in Diagram III. are interesting, as showing the greater illumination obtained on increasing the aëration up to a certain limit, and its subsequent falling off when too much air was added. Starting with too little air, curve *a* shows a considerably lower illumination both at the bottom and top of the mantle than curves *c* and *b*. The addition of a little air evidently caused the flame to shrink and fit the mantle better. At this consumption of carbon monoxide, this degree of aëration gave the best duty (curve *c*). The addition of more air apparently brought the flame inside the mantle, and there is a general lowering of the illumination over most of the surface—curve *b*. At this point, the consumption of carbon monoxide was increased; the flame became larger again; and curve *d* was obtained. Here the illumination was better all over the mantle. The ratio of air to gas was now lower than that for the last maximum duty. Therefore, on increasing the air again, the candle power rose in accordance with expectation. The illumination curve for this experiment was not determined. On further increasing the consumption of gas and air, the illumination of the upper half of the mantle, which in curve *d* is not so good as that of the lower half, was increased, and curve *e* was obtained. The ratio of air to gas for curve *e* is higher than that for curve *d*. A further increase of added air lowers the duty as shown in the table. The illumination curve for this experiment was also not determined. The results in Tables III. and IV. are in entire accordance with M. Sainte-Claire Deville's conclusion that the ratio of air to gas required for the maximum duty increases with the actual consumption of the gas.

The consumptions of carbon monoxide shown in Table IV. were the highest that had been used up to this stage of the work. Comparable rates of consumption of hydrogen are shown in Table IVA.

TABLE IVA.

H_2.	Air.	C.P.	$\frac{C.P.}{H_2.}$	$\frac{Air.}{H_2.}$
2·4	0·94	9·47	3·94	0·39
2·92	*nil*	5·38	1·84	*nil*
3·44	1·22	9·0	2·62	0·36

The difference in "duty" afforded by hydrogen and carbon monoxide in all the experiments so far considered is striking. In Tables II. and IIA, the duty for carbon monoxide is considerably more than double that shown by hydrogen under similar conditions. In Tables IV. and IVA., the duty afforded by carbon monoxide was also very much superior to that afforded by hydrogen; but the comparison is, in this instance, perhaps not altogether a fair one. For whereas in the case of the carbon monoxide the flames were all well aërated, in the case of the hydrogen they were badly aërated, although as highly aërated as the construction of the burner would permit. It has nevertheless been shown that in all cases where hydrogen and carbon monoxide have been compared under similar conditions of aëration, the advantage has always been overwhelmingly in favour of carbon monoxide. Moreover, since with any ordinary atmospheric burner carbon monoxide may be burned with a much greater degree of aëration than is possible to obtain with hydrogen without the flame striking-back, it may be concluded that, under such conditions, carbon monoxide will give a higher maximum duty at every rate of consumption.

The problem of designing a form of burner which would permit of a thoroughly aërated hydrogen flame presented many difficulties; but after much experimenting it was successfully solved by the design of burner No. 3A, now to be described.

Burner 3*a*.—A sketch is shown of this in fig. 1A. The mixture of gas and air enters at *a* (which is made to fit the top of the tube *d* in fig. 1) into a horizontal tube *b*, from which two upright pipes *c* lead to a gallery *d*. This gallery completely encircles the burner-head. Holes drilled on the inside of the gallery allow the passage of the gas and air into the slit *f*, which also extends all round the burner-head, and from the top of which the mixture is burnt. The inside surface of the slit is the circular water-jacket *e*, which cools the gaseous mixture while the restricted width of the slit causes the mixture to move forward towards the flame at a high velocity.

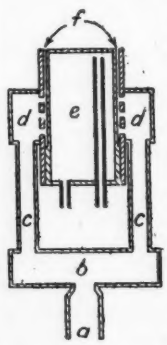


Fig. 1B.—Section of Burner Heads Nos. 3a and 3b.

It is obvious that such a burner as the above is very far removed from anything that is likely to be used in actual practice, and that therefore in some respects the remaining experiments may be said to have been carried out under quite artificial conditions. But since the object of the research was the comparison of the illuminating efficiencies of hydrogen and carbon monoxide both burning under the most favourable conditions, it seemed neither necessary nor desirable to impose any arbitrary limit as to the design of a burner. In the first experiments with the new burner, the width of the slit was only 0·074 inch, and while it was possible to maintain a fully aërated flame of hydrogen without

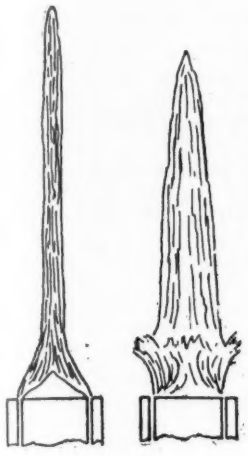


Fig. 2.—H_2 flame well aerated.

Fig. 3.—CO flame well aerated.

any danger of it striking-back, the extremely narrow opening only permitted of comparatively low rates of consumption. In these circumstances, very poor results were obtained as regards maximum efficiency. On investigation, this seemed to be due primarily to the shape of the flame, which is shown in fig. 2. It assumed a long, tapering, pencil-like form; and though this is not necessarily an indication of its shape when the mantle was placed in position, it obviously did not particularly conform to the outline of the mantle. Nevertheless, even with this burner, under similar conditions as regards aëration, a 40 per cent. higher duty was obtained with carbonic oxide than with hydrogen. The slit of the burner was now widened to pass 50 per cent. more gas than in its original condition; and the final experiments were performed with the burner-head thus altered. Under the new conditions, it was at length possible to follow the maximum duty curve for hydrogen with increasing consumptions up to a point at which it ceased to rise.

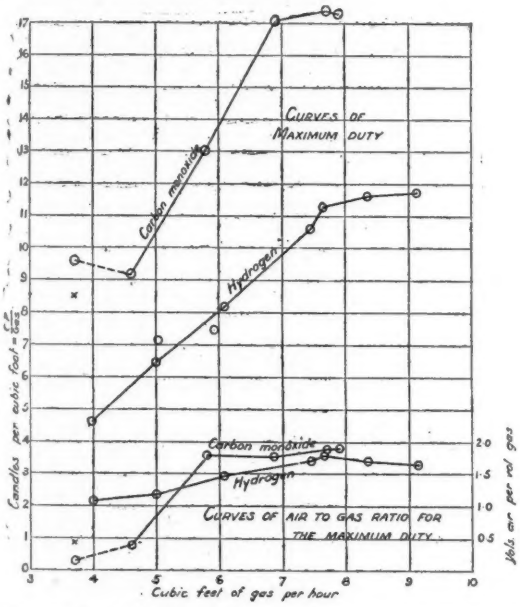

Curves of Maximum duty
Carbon monoxide
Hydrogen
Carbon monoxide
Hydrogen
Curves of air to gas ratio for the maximum duty
Candles per cubic foot = C.P. Gas
Vols. air per vol. gas
Cubic feet of gas per hour

Diagram IV.—Curves of Maximum Duty and of Air-to-Gas Ratio.

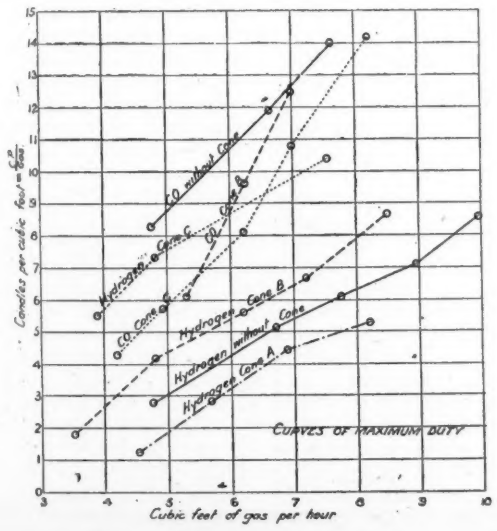


Diagram V.—Curves of Maximum Duty.

Such a slit burner, however, is not well adapted for the combustion of carbon monoxide, owing to the flame being partially blown away from the slit, as shown in fig. 3. So that if hydrogen and carbon monoxide are to be finally compared under the most favourable circumstances for each, the results obtained with the slit burner for hydrogen must be compared with those obtained by means of burner No. 2 for carbon monoxide. This comparison is shown in Tables V. and VI. The "duty" curves constructed from the figures in Tables V. and VI. are compared in Diagram IV.

TABLE V.

H_2.	Air.	C.P.	$\frac{C.P.}{H_2.}$	$\frac{Air.}{H_2.}$	$\frac{C.V. \times H_2.}{C.P.}$
3·98	4·31	18·4	4·62	1·08	16·0
5·01	5·92	32·2	6·43	1·18	11·5
5·04	6·68	36·2	7·18	1·32	10·3
5·92	8·65	44·6	7·53	1·46	9·8
6·07	9·24	49·5	8·16	1·52	9·06
7·46	12·76	78·7	10·55	1·71	7·00
7·65	13·67	86·5	11·31	1·78	6·54
8·35	14·25	96·5	11·56	1·71	6·39
9·13	15·13	108·0	11·76	1·65	6·3

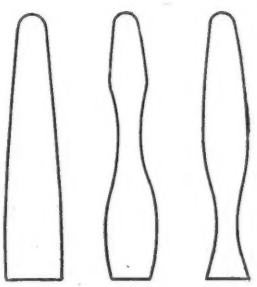
TABLE VI.

Co.	Air.	C.P.	$\frac{C.P.}{Co.}$	$\frac{Air.}{Co.}$	$\frac{C.V. \times Co.}{C.P.}$
3·72	0·61	35·53	9·57	0·16	8·73
4·62	1·81	42·4	9·18	0·39	9·1
5·8	10·55	75·5	13·05	1·83	6·4
6·87	12·27	117·2	17·06	1·78	4·89
7·69	14·64	133·2	17·33	1·90	4·82
7·91	15·22	137·0	17·31	1·92	4·82

The maximum duty obtained for hydrogen at a consumption of 9·13 cubic feet per hour was 11·76 candles per cubic foot—a result which must be compared with the 17·33 candles per cubic foot obtained for carbon monoxide at a consumption of 7·69 cubic feet per hour. The ratio of the maximum efficiencies for carbon monoxide and hydrogen is therefore 1·47, as compared with a ratio of 1·13 for their net calorific values.

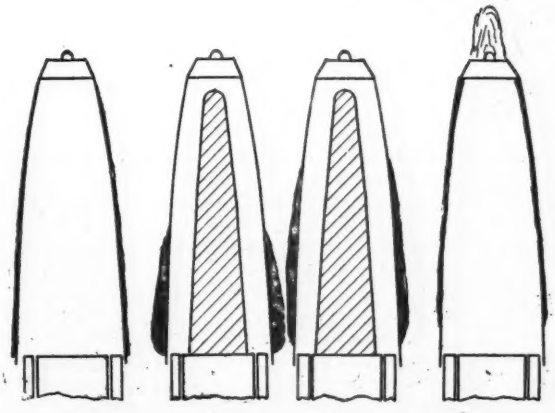
Variation of Shape of Flame and its Influence upon the "Duties" Obtainable from the Gas.

The experiments on hydrogen with the slit burner had suggested the desirability of endeavouring to alter the shape of the flame by the use of porcelain cones, so as to confine the combustion as far as possible to a hollow shell corresponding to the outline of the mantle. For this purpose, hollow cones of white porous porcelain of three different shapes, as shown in fig. 4, were prepared by Messrs. Doulton and Co., of Lambeth. The surface of cone A was so made as to be parallel to the surface of the mantle, while the outlines of the other two cones were designed for the purpose of deflecting the flame as much as possible, either towards the bottom or towards



Cone A. Cone B. Cone C.

Fig. 4.



4. 3. 1. 2.

H_2 with and without Cone A. CO with and without Cone A.

Fig. 5.

the top of the mantle as circumstances might seem to require. In comparing the cones as shown in fig. 4, it will be noticed that B and C are both derived from A, by reducing the diameter in certain places. As might be expected, the alterations thus caused in the contour of the flame affected the curve of maximum duty at different consumptions in a very marked manner. The effect of using the cones is shown in Tables VII. and VIII., from which the duty-curves in Diagram V. have been constructed.

TABLE VII.

Diagram and Curve.	H_2	Air.	C.P.	$\frac{C.P.}{H_2}$	$\frac{Air}{H_2}$	$\frac{C.V. \times H_2}{C.P.}$
	No Cone					
VI. a_1	9·68	15·37	85·5	8·84	1·59	8·36
a_2	9·94	14·64	[85·5	8·60	1·47	8·59]
b	8·95	13·02	63·5	7·10	1·45	10·41
c	7·77	10·94	47·5	6·11	1·41	12·10
d	6·69	8·14	34·5	5·16	1·22	14·33
e	4·75	4·29	13·05	2·75	0·90	26·88
	Cone A					
VII. *a*	10·03	13·65	40·0	3·99	1·36	18·52*
b	8·22	13·10	43·8	5·33	1·59	13·87
c	6·87	10·93	30·7	4·47	1·59	16·53
d	5·65	7·96	16·2	2·87	1·39	25·76
e	4·52	5·06	5·7	1·26	1·12	58·57
	Cone B					
VIII. *a*	8·5	15·63	73·4	8·63	1·85	8·56
b	7·21	12·66	48·0	6·66	1·76	11·10
c	6·19	10·26	34·55	5·58	1·66	13·24
d	4·81	7·17	20·15	4·19	1·48	17·62
e	3·51	4·62	6·35	1·81	1·31	40·87
	Cone C					
IX. *a*	8·58	14·02	82·6	9·63	1·63	7·67*
b	7·52	12·54	78·3	10·42	1·67	7·09
c	6·73	8·76	45·02	6·69	1·30	11·05*
d	4·80	6·18	35·2	7·34	1·29	10·07
e	3·87	5·07	21·3	5·50	1·31	13·44

* Evidently short of air.

TABLE VIII.

Diagram and Curve.	CO.	Air.	C.P.	$\frac{C.P.}{CO.}$	$\frac{Air.}{CO.}$	$\frac{C.V.+CO.}{C.P.}$
	No cone					
X. *a*	7·61	13·32	106·5	13·99	1·75	5·97
b	6·62	12·77	79·5	12·01	1·93	6·95
c	6·03	9·33	57·5	9·54	1·55	8·75
d	4·76	1·11	39·3	8·26	0·23	10·11
	Cone A					
XI. *a*	7·38	13·95	88·5	11·99	1·89	6·96
b	6·57	12·29	72·0	10·95	1·87	7·62
c	5·80	9·64	61·8	10·65	1·66	7·84
d	4·46	4·11	23·75	5·32	0·92	15·70
	Cone B					
XII. *a*	8·14	14·6	108	13·26	1·79	6·3
b	6·98	11·40	87·8	12·57	1·63	6·63
c	6·24	8·28	60·0	9·62	1·33	8·68
d	5·31	6·70	32·6	6·14	1·26	13·59
	Cone C					
XIII. *a*	8·2	14·4	116·2	14·19	1·76	5·89
b	6·98	10·24	75·5	10·81	1·47	7·72
c	6·23	9·30	50·5	8·11	1·49	10·3
d	4·93	3·82	27·4	5·68	0·77	14·7
e	4·18	2·09	18·05	4·31	0·5	19 36

One fact is made plain from a consideration of these tables and diagrams—namely, that both for hydrogen and carbon monoxide the curve of "maximum duties" is altered considerably by the cones as far as it has been possible to follow it, and that different shaped cones have different effects. Two reasons may be advanced in explanation of this alteration of the curves. They are:

1.—The "quickening" or concentration of the flame owing to increased surface combustion, or some such similar cause.

2.—The deflection of the flame according to the shape of the cone.

In considering the first, it is necessary to look at fig. 5. This consists of four sketches, showing the relative distribution of brightness of the illumination given by (*a*) carbon monoxide with cone as in sketch No. 1, and without a cone in sketch No. 2; (*b*) hydrogen with cone as sketch No. 3; and without a cone in sketch No. 4. The illumination is distributed in a very equal manner over the mantle surface when the cone is not in use. On the contrary, when the cone A is in use the illumination appears to be mostly on the bottom parts of the mantle, and is much more brilliant—a statement which is proved in the particular experiments illustrated by the fact that the duty afforded was higher in both cases with the cone than without it. [This is not, however, always the case. Concentration of the illumination invariably occurs when any cone is used; but increase in the total candle power is not always effected by concentration.]

With regard to the second reason, the effect of deflection can be clearly observed on examining the illumination curves given in Diagrams VI., VII., VIII., and IX. for hydrogen, and X., XI., XII., and XIII. for carbon monoxide. [The lettering of the curves refers to the lettering in Tables VII. and VIII.]

Hydrogen.—In Diagram VII., it is seen that with cone A the illumination is principally at the bottom of the mantle, and falls away rapidly as the upper portions are approached; whereas in Diagram VI., without a cone, the falling away is not nearly so rapid, and the upper portions of the mantle are comparatively well illuminated. In Diagram VIII., the effect of cone B is shown to be in the same direction as cone A at the bottom of the mantle; but at the top it allows of better illumination. In Diagram IX., cone C, with its slender bottom and bulging top, causes the flame which has partially escaped the previously-mentioned quickening action of the wide bottomed cones A and B to be deflected on to the upper portions of the mantle, with a consequently improved illumination there.

Carbon Monoxide.—The effects are very similar. Without a cone (Diagram X.), there is a very even illumination over the mantle surface. Cones A and B (Diagrams XI. and XII.) cause quickening of combustion and better illumination at the bottom and less in the upper portions, while cone C (Diagram XIII.), causing less quickening and concentration of illumination at the bottom, gives better illumination at the top of the mantle than the other cones.

Returning to the effect of the cones on the duty curves (Diagram V.), it must be concluded that, as far as the curves go, they show that the duty afforded by hydrogen can be raised by the use of a suitably shaped cone. Whether or not the duty can be permanently raised can only be decided when the curves can be followed as far as the flat part. At low consumptions at any rate there is an actual improvement. In the case of carbon monoxide, no actual improvement is effected by the cones, though the direction of the duty curves when the cones are used indicates a quicker rise of duty for a given increase in the rate of consumption than without them. Could the curves be further extended, it is possible that the horizontal part of the steeper curves would be higher than that for the less steep curve for carbon monoxide without a cone. As this can only be settled by further experiment, the only definite conclusion so far established

ILLUMINATION CURVES FOR HYDROGEN.

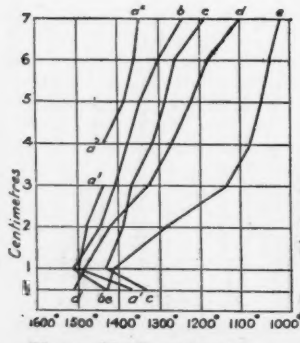


Diagram VI.—H_2 without Cone.

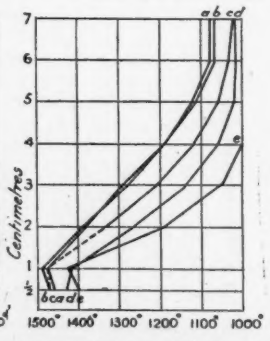


Diagram VII.—H_2 with Cone A.

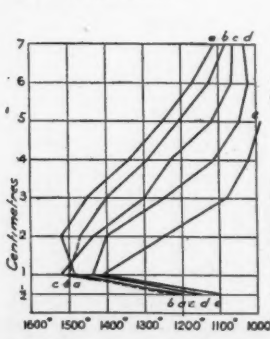


Diagram VIII.—H_2 with Cone B.

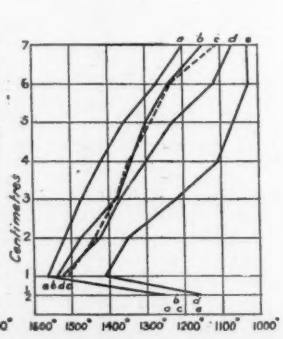


Diagram IX.—H_2 with Cone C.

ILLUMINATION CURVES FOR CARBON MONOXIDE.

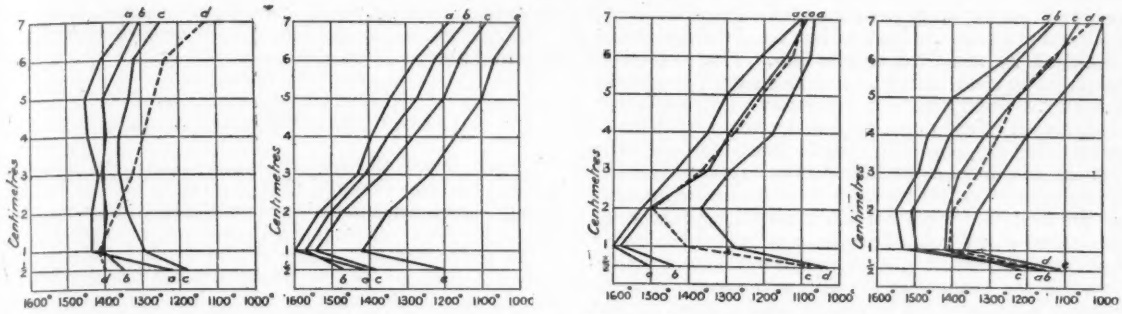


Diagram X.—CO without Cone. Diagram XI.—CO with Cone A. Diagram XII.—CO with Cone B. Diagram XIII.—CO with Cone C.

by the use of the cones is the fact that they cause quickened combustion, and therefore concentration of illumination.

CONCLUSIONS.

The principal conclusions arrived at during this investigation may be summarized as follows:

1.—When hydrogen is burnt in an ordinary atmospheric burner with a degree of aëration up to a ratio of $\frac{\text{Air}}{H_2} = 0{\cdot}5$—*i.e.*, the highest possible with such a burner—the duty afforded steadily decreases with a rising rate of gas consumption.

2.—The distribution of luminosity over the mantle with such a burner is vastly different with hydrogen than with carbon monoxide under similar conditions.

3.—With an ordinary burner, carbon monoxide invariably gives a very much higher duty than hydrogen.

4.—When, by suitable manipulation, hydrogen was made to burn in a well-aërated condition, the highest duty obtained was 11·7 candles per cubic foot, with a ratio of $\frac{\text{Air}}{H_2}$ = about 1·7. This, compared with the best result for carbon monoxide—viz., 17·3 candles per cubic foot with a ratio $\frac{\text{Air}}{CO} = 1{\cdot}9$—shows a 48 per cent. margin in favour of carbon monoxide. A comparison of their calorific values as used in the test shows only a 13 per cent. advantage in favour of carbon monoxide.

5.—The use of cones inside the mantle causes a quickening of combustion and concentration of illumination.

In conclusion, the author desires to thank Professor Bone for his constant interest and advice during the course of the investigation, and his kind assistance in the compilation of this paper.

Discussion on Mr. Forshaw's Paper.

The PRESIDENT said it could not but be gratifying to the Institution to know that such careful experiments and such scientific work had been carried on, with the object of finding the conditions which existed in the incandescent mantle, which was now so favourite a form of gas lighting. It was a highly scientific problem. The investigation had dealt with two gases which, among others, they distributed; and for the purpose of the investigation it had been necessary to find the conditions which existed when pure hydrogen and carbon monoxide were used in burners of different descriptions. They all knew that different gases affected the shape of the flame and the intensity of the illumination in a mantle. A mixture of water gas and coal gas gave a different shaped flame, and required a burner of slightly different proportions, from that used for pure coal gas. They also knew that the intensity of combustion when there was a mixture of water gas and coal gas was greater than with pure coal gas. It was very important for the progress of incandescent lighting that they should recognize that the shape and the local intensity of the flame depended on the mixture of gases in relation to the design of the burner. Their friends in the trade who were developing the incandescent burner, both upright and inverted, were no doubt keeping this point in view; and, fortunately for them all, the construction of the inverted burner seemed to have been a comparatively easy matter for developing a higher candle power per cubic foot than had been the case with the upright burner. There seemed to be fewer difficulties in the way of obtaining a higher duty. As many of them knew, it was not difficult to get 20 candles per foot, at an angle of about 80°, from an ordinary inverted burner which could be purchased on the market. This was very gratifying; but it was possible that by such investigations as these even better results might be obtained, and there was evidently room for further investigation and development. Before opening the discussion, he would ask the Honorary Secretary to read several letters which had been received bearing upon the subject.

Mr. SHOUBRIDGE read the several letters, as follows:—

[From M. SAINTE-CLAIRE DEVILLE—Translation.]

I have only a very rudimentary knowledge of the English language, and so it is not possible for me in a few hours to thoroughly fathom the sense and bearing of Mr. Forshaw's letter. . . . I should like to be excused if this letter reveals the fact that I have not entirely understood the communication.

My impression is that there is no contradiction between the conclusions of Mr. Forshaw and my own. Mr. Forshaw considers gases chemically pure, and asks himself whether the luminous value of these gases, in a state of incandescence, varies proportionately to their calorific power; He particularly compares carbon monoxide and hydrogen. and he finds that the maximum yield of the former is far higher than the maximum yield of the latter. This in no way astonished me; and I do not think I ever expressed a contrary opinion. It seems, in fact, that there is no necessary correlation between the heat of combustion of a gas and the amount of its luminosity in the mantles. The theoretical temperature of combustion of the gases seems, *à priori*, to be a more important factor of this yield. But it is not at all from this point of view that I started to study the question.

My first labours on this subject date from 1894. At that time incandescence was in its infancy; and in Paris, at any rate, there could be no question of distributing to consumers any other gas than coal gas. The only method of controlling the quality of the gas was the determination of the lighting power of the flames, as defined by Dumas and Regnault. It appeared thereupon that a coal gas giving, on the Dumas and Regnault photometer, a lighting power quite insufficient, might nevertheless be perfectly usable for lighting by incandescence. People might have asked themselves whether it would not be advisable to create another method of measuring light, to determine the lighting power of gas by incandescence, after having defined it with precision. It was then that I undertook the systematic comparison of the heats of combustion of coal gases with their lighting powers by incandescence. I adapted to an ordinary burner a feed of air capable of being regulated and measured. Then, keeping the gas pressure constant at the point of consumption, I regulated the air in such a manner as to realize the maximum luminous intensity for the gas used. This work shows—in fact, it is found—that the quantity of light obtained per 1000 calorific units used up under the mantle is about constant for all coal gases. I have since established a peculiarity which has the effect of making this probable enough—namely, coal gases, from the poorest to the richest, all have a theoretical temperature of combustion about equal, and in the neighbourhood of 1950°.

In 1901, I again took up this question—modifying the definition of the lighting power of a gas by incandescence.

I admitted that this characteristic lighting power would be, not the maximum luminous yield at a moderate expenditure, under normal pressure, but the absolute maximum luminous yield obtained by intensive combustion. The method of ascertaining this yield seems to me to be pretty correctly stated by Mr. Forshaw early in his paper. I also affirmed (confining myself in my remarks to coal gases only) that the proportion of lighting power by incandescence to the calorific power of the gas, may be considered as an experimental fact sufficiently established for there to be no necessity, in commercial practice, to directly control the lighting power by incandescence (which would be extremely difficult) in order that a gas manufacturer might consider himself to be acting fairly towards the consumers when he has furnished them with a gas of a higher calorific power than an agreed figure. The investigations of 1901 were published by the International Commission on Photometry at the close of the session of 1903.

In 1905 I again took up the question, for the purpose of inquiring within what limits a mixture of water gas with coal gas might modify my first conclusions. I recognized that water gas gives a little more light per 1000 heat units than coal gas, but that, taking it altogether, the trouble occasioned to the law of proportions is of slight importance, and may be neglected in practice. [See the researches published by the International Commission of Photometry at the close of its session of 1907.]

It is thoroughly understood, besides, that these conclusions are only applicable in the case of the supply of a gas on the basis of coal gas. Still, I think that if a company furnishes the public in a regular way with carburetted water gas, the accidental variations of yield of light by incandescence would be accompanied by variations in the same direction of the calorific power of the gas. But the average value of the luminous yield per 1000 units of heat would doubtless be a little higher than in the case of coal gas, whether mixed or not with water gas, and carburetted if necessary with benzol.

[From Professor A. G. Vernon Harcourt.]

The total light sent forth from an incandescent mantle is obviously the sum of the different quantities of light from a number of equal areas into which its surface may be divided. The greatest light is given out from such of these unit areas—square centimetres, one might take it—as are in the hottest part of the flame. Other parts of the surface contribute in various less degrees, according to the temperature of the part of the flame with which they are in contact. The hottest part of a flame is its outside—a part scarcely visible—where the last of the gas, already highly heated, is finally burnt.

If a tongue of flame and a mantle could be so shaped to fit one another as that nearly all the mantle was just dipping into the outside of the flame, the result would be excellent with any ordinary gas. Still there would be differences between one gas or mixture of gases and another. If other conditions could be made alike, the flame temperature would vary with the calorific value of the gas; and it is interesting to see, from the measurements quoted by Mr. Forshaw, how nearly these two are proportional, judging by the necessarily rough test of the illumination produced by the application of the flame to a mantle.

Another property of gases, besides their calorific value, which affects flame temperature, is their rate of combustion. Mr. Forshaw writes: "The rate of combustion of hydrogen is known to be very much higher than that of carbon monoxide;" and he connects this most justly with the great difference between the diffusion rates—*i.e.*, rates of molecular movement—of the two gases.

Since the temperature of a flame depends upon the difference between the heat that is produced and the heat that is given off during each moment of time, it is clear that when the rate of combustion (which is the rate of heat production) is greater, the temperature of the flame will be higher.

Mr. Forshaw has attempted a most difficult estimation, owing to the great difference between the shapes of the flames of hydrogen and carbonic oxide burning from the same burner, and the different fitting of similar mantles to flames of different shapes; and if different burners are used for the two, there is an uncertainty, due to the influence of the burner.

I hope that Mr. Forshaw may be continuing his research; and I venture to prophesy that if he can succeed in producing really comparable flames of the two gases, better without previous admixture of air which complicates the case, he will obtain at least as good an incandescence from hydrogen as from carbonic oxide.

[From Professor William A. Bone.]

I have much pleasure in testifying to the sustained industry and experimental skill displayed by Mr. Forshaw during his eighteen months' tenure of the Institution Research Fellowship; and although I must leave it to others to judge of the pertinence and value of the work he has accomplished, I perhaps may be allowed to express the opinion that, as regards devotion to his subject and conscientious desire to secure accuracy of his results, he has established a record which it will be difficult for any of his successors to surpass. It is equally gratifying to the Institution, the University, and myself that before the two years of his tenure of the Fellowship had been completed, an opening as Research Chemist to a large firm engaged in the manufacture of gas-heating appliances was found for him. In this respect, also, a happy precedent has been created.

With respect to the subject of the paper, there can be little question of the importance of the careful determination of the relative illuminating efficiencies of various gases when used in conjunction with the incandescent mantle. So far as can be judged at present, the future of "gas lighting" seems largely dependent upon the extended use of the mantle, and therefore the elucidation of the many scientific problems connected with its function as a "heat-light" engine cannot fail to be of ultimate value to the industry.

During recent years the opinion has been gaining ground that the illuminating efficiency of a combustible gas used in conjunction with an incandescent mantle is proportional to its net calorific value; and in consequence it has become the fashion to regard the calorimeter as the ultimate measure of the value of gas for both lighting and heating purposes. At first sight no doubt this belief may seem plausible enough, and there is a certain amount of experimental evidence in its favour; but on close examination this evidence is insufficient and lacking in cogency. Moreover, the belief ignores such chemical factors involved in gaseous combustion as the relative combustion "intensities" of different gases, and the influence of hot surfaces thereon, as well as the known complexity of even apparently simple cases of combustion. I venture to think that few chemists who have specially studied gaseous combustion would subscribe to the "calorimetric" doctrine, at least on the strength of the evidence so far advanced in its support.

Past investigators, no doubt with a view to the immediate practical value of their work, had chiefly busied themselves with complex mixtures of gases, with the result that it was impossible from their results to discriminate between the various factors operative in determining the "mantle efficiency" of a gas. Mr. Forshaw has attempted what has proved to be the much more difficult task of comparing the efficiencies of two single gases, having nearly the same calorific values, but different rates of diffusion and combustion intensities, and where rates of combustion were also differently affected by hot surfaces. The results obtained have borne out the anticipation that the efficiency depends upon other factors than mere calorific values; and from that point of view they might be commended to the careful attention of all illuminating engineers. The precise definition of these other factors must be left to further inquiry.

The original programme of work mapped out for Mr. Forshaw included the examination of methane; but partly owing to the great experimental difficulties encountered in the cases of hydrogen and carbon monoxide (difficulties which often entailed delays on account of reconstruction of the burners used), and partly to the fact that Mr. Forshaw had, by reason of his industrial appointment, to resign the Fellowship before completing his two years' tenure, the investigation of methane had to be left to his successor.

A novel feature of the paper are the "illumination curves" which indicate the distribution of illumination over the mantle surface. The ingenious optical pyrometer invented by M. Féry had provided an easy and convenient method of determining the distribution of luminosity, the importance of which would be evident to anyone who would study Mr. Forshaw's figures. The experiments on the use of cones were also valuable in suggesting lines of further work and progress.

Mr. Forshaw would probably be the last to claim any degree of finality for his work or conclusions, and the paper must not be considered as embodying anything more than a clear statement of experimental results from an unbiassed standpoint. His conclusions would be extended and possibly modified by his successors in the Fellowship, and ultimately they might hope to get their feet planted on the bed-rock of truth in regard to this matter.

I should like to add that the paper embodies only a part of the results of Mr. Forshaw's industry; he has also co-operated with me in experiments on the important subject of "Surface Combustion," the results of which will appear in due course.

[From Mr. JOHN W. BRAY.]

I think the paper will give rise to some very interesting discussion, which I should like to have heard. To my mind, the construction of the burner is of prime importance in any comparison between the illuminating powers of various gases.

My own experience has been that a burner suitable for coal gas will require modification when used with water gas, acetylene, &c. Perhaps, therefore, if Mr. Forshaw had modified his burners even slightly, he might have found an explanation of the difference in the illuminating efficiencies of hydrogen and carbon monoxide.

The same burner used for these gases may not give comparable conditions. These may only be obtained when burners giving the maximum efficiency are employed.

However, I think the results embodied in the paper are most interesting; and I shall look forward to an extension of the experiments, when what I may term the ordinary commercial illuminating gases are used.

Mr. THOMAS HOLGATE (London) said that he had much pleasure in bearing his testimony to the excellent work Mr. Forshaw had done; and he thought perhaps its importance was not circumscribed by his references to the incandescent burner. If they found out the value in an incandescent mantle of the constituents of town gas, it would be one factor enabling them to value the gases they were getting from the older and newer methods of gas production. He had had the pleasure of some correspondence with M. Sainte-Claire Deville, upon the work which that scientist had so admirably performed during a series of years; and he believed that any apparent inconsistency which might appear between his published work and that as now brought forward was only apparent, and that further study would show an essential agreement. Perhaps the reason why M. Sainte-Claire Deville emphasized the question of calorific power as being the one factor was that in his early days he tested mixed gases which had on the average the same flame-temperature; and that being so, it was quite manifest that equal volumes of such a gas must have a value in an incandescent burner approximately determined by the calorific power. The flame-temperature continuing the same, there were no means of comparing the variation of any factor but that of calorific power. Had M. Deville taken gases with different flame-temperatures, he would have found out the influence of the two factors. He (the speaker) thought the French scientist's later work provided a means of testing this. In later years, he tested blue water gas; and if one was careful to dissect the data he provided, it was possible to form a scale of results which showed that the highest efficiency corresponded with the gas which gave the highest flame-temperature. The increase so observed proceeded according to the fourth or fifth power of the increase of flame-temperature. This led him to ask whether Mr. Forshaw had made any observation upon the temperatures of the flames. He noticed that the figures he gave of the temperature of the mantle showed that the mantle was at a higher temperature with a carbon monoxide flame than with hydrogen; and this would, of course, indicate a corresponding increase of luminosity. But had he made any observation on the actual temperature of the two flames—the hydrogen and the carbon monoxide? If he had not, could he suggest any other reason than the difference in flame-temperature for the relative efficiency he had found? If they took the ratio between the flame temperature of hydrogen and carbon monoxide, and took the fifth power of that, they would get a figure which along with the ratio of their calorific values entirely corresponded to his observed figures of 11·7 and 17·3. Further, he would point out that, in the burner which Mr. Forshaw finally adopted for the hydrogen flame, he had an arrangement for cooling the gas on its way to the burner, in order to prevent back-firing; and he might ask if it was at all likely that any abstraction of the heat took place from the flame by the contiguity to it of that mass of water. They had in the paper one set of figures from carbon monoxide gas where no such disturbing element arose; and the question was whether they were to attach any importance to this dissimilarity. Lastly, he desired to emphasize the value of getting fundamental data relating to each gas.

Mr. LEON GASTER (London) said it was a great privilege to be present at that meeting. He congratulated the Institution on having had this investigation started, because it was of the greatest importance to them to really have correct information as to the relative merits of different illuminants, so that they might know what part each gas is playing in the incandescent method of lighting. Illumination, dealing with a physiological subject, naturally gave rise to a great deal of imagination and speculation. The paper had certainly presented in a very clear manner what these two gases under given conditions were capable of doing; and Professor Bone, in his letter, added that when they had dealt with the other gases used for illumination and their relative efficiencies, they would know more about the *rôle* played by those now under investigation. Nevertheless, an important piece of work had been done. He wished to express his own thanks particularly to the Institution for their co-operation with the Electro-Technical Commission on the question of the international candle. Only the day before, he had a letter from Washington expressing satisfaction at the co-operation of the Gas Institution with the Commission and the Gas Referees in this country, and which had led to the understanding with regard to an international unit of light. It was very gratifying to find that the unit of light adopted was that given by the 10-candle power Harcourt pentane lamp; and if this unit was generally adopted, everything would be expressed more clearly. For comparison purposes, it was essential to know whether the illumination measurements were taken horizontally, mean, spherically, or hemispherically, as illumination figures, without knowing what they really meant, were misleading. He did not blame gas engineers for taking the horizontal figure, because it suited them best; but it was not so good for proper comparisons. He believed there was room for every illuminant; and he only wanted to know where each should be placed according to its true merits. This investigation no doubt would contribute to settle a great many points with regard to gas; and it ought to be further continued, to the benefit of the gas industry in particular, and of illuminating engineering generally.

Mr. J. P. LEATHER (Burnley) said the paper was of great interest to him, not so much because of the conclusions set out at the end, but from the fact that a commencement had been made with a scientific investigation of illumination by the incandescent mantle. In ancient days, the alchemist worked with recipes containing a dozen different constituents to produce a simple thing, without knowing whether some of them were either necessary or useful; and the progress of chemistry in the Nineteenth Century was due to this old system having been abolished and a search being made to find the value of each constituent. Up to the present time, all the work on incandescent mantles had been on the old system of the alchemist, dealing with the complex mixture called coal gas—different observers using different mixtures, because they had gas produced in different localities. Now they were beginning to separate the gases, and to know what each gas meant; and when this was done, they would be in a better position to know what to aim at in their manufacture. Mr. Forshaw exercised a wise discretion, no doubt, from some points of view, in choosing hydrogen and carbon monoxide for his experiments, because they were the simplest gases that he could work with, and he could obtain them readily in a state of comparative purity. But he had got into certain difficulties through choosing these gases, largely due to the fact that they required so small a proportion of air for complete combustion —namely, only about 2·38 volumes of air as compared with 5½ to 6 volumes in the case of ordinary coal gas, or 9½ volumes in the case of marsh gas. This made a very considerable difference to the way in which the gas was to be burned, and to the burner; and it lent emphasis to the remarks of Dr. Colman on the importance of considering whether they were making marsh gas or hydrogen in their

retorts. While the results of the experiments of Mr. Forshaw were of great interest and value, and they were much indebted to the author for his researches and the diligence he had bestowed on them, he thought in his conclusion he had stated things perhaps not with very great definiteness, but which were hardly borne out by the facts. For instance, he had left the straight and narrow way for bye-path meadow when he talked about surface combustion. No doubt this was due to the hypnotic influence of those who thought there was something in surface combustion. As far as he knew, the argument in favour of it was this, that at high temperatures hot surfaces produced decomposition, and therefore, by the homeopathic law, might also be expected to cure it and promote combination. While dealing with the question of cones, he (Mr. Leather) would point out that there seemed to be a discrepancy between Tables VII. and V. In Table VII., hydrogen without a cone gave, with a consumption of about 7½ cubic feet per hour, only 6 candles per foot, compared with 10 candles when cone C was used. But in Table V. hydrogen without a cone gave over 10½ candles with the same consumption of hydrogen. So that although in one of the diagrams hydrogen was shown to give a better result with a cone than without, the tables, taken together, did not bear this out. M. Casaubon, of Brussels, and several other investigators, whose names he did not remember, had done work which tended to prove, and not only scientific investigation but general practice showed, that they got the best results in illumination when the full theoretical proportion of air was introduced into the mixture before it entered the burner. For instance, with a Kern burner, which drew in about 75 per cent. of the full theoretical quantity, they got 20 candles; but when, by means of higher pressure or specially constructed burners, a greater quantity was drawn in, they got 30 candles and upwards. It did not seem fair to compare the value of hydrogen and carbon monoxide, when in no case had the author succeeded in getting in more than about 70 per cent. of the theoretical quantity of air required. He told them that when he increased the quantity beyond a certain point the duty again diminished; but that was probably due to the fact that the burner was not suitable to the gas and the mantle. This was a very complicated question. In determining the illuminating value of gas in an incandescent burner, they had not only the gas, the air, and the burner to consider, but also the mantle. With an exceptional gas like hydrogen, they must not only construct the burner, but also the mantle for the purpose. Again, there was the question of burning the full theoretical quantity of air. Mr. Forshaw said he was not able to do it with the first burner he had. He (the speaker) would not like to say definitely he could have done it. But it did strike him, when he read the paper (which had been sent to him beforehand), that it ought to be capable of being done; and although he had only two days, he thought he would try to do it. He constructed a burner out of materials at hand—quite of the ordinary character. At first he started very much as Mr. Forshaw did, and got the same difficulty. He turned on the hydrogen and then turned on the air; and as he turned on the air beyond about the figure Mr. Forshaw had given, he got the burner lighting-back. He spent some little time on these experiments, because he thought he would check Mr. Forshaw's figures; and he got figures quite as good as, if not better than, any of his as regarded illuminating power. He could not give the figures, because he had not time to do a great deal of exact work; but taking one result which he corrected for temperature and pressure, with a consumption of hydrogen of 7·8 cubic feet and 3·6 feet of air, he got an illuminating power of 93 candles, or 11·9 candles per foot—fully equal to the best result Mr. Forshaw obtained with a specially constructed burner, and with a higher quantity of air. The mantle was a Welsbach No. 4. It was a bigger burner than Mr. Forshaw had been working with; and he (Mr. Leather) had to use a mantle to fit his burner-head. In some other experiments in which he did not determine the proportion of air accurately, but with a slightly higher consumption of hydrogen, he got an apparently higher result than that—somewhere about 12 or 13 candles, when corrected for temperature and pressure, per foot of hydrogen. But this did not suit him altogether. He felt that they ought to get the full theoretical quantity of air mixed with the hydrogen before the point of ignition if possible; and when thinking it over, he had previously calculated out that with this the burner ought not to light-back. If they were burning 8 cubic feet of hydrogen in a burner with a mixing-tube ¼ inch in diameter, and 2·4 times its volume of air, they would have a velocity of 22 feet per second; and at this rate the burner ought not to light-back, because it was greater than the velocity of propagation of inflammation in a mixture of hydrogen and air. If they started with hydrogen and gradually introduced the air, they had not got that velocity; and when they got up to a much smaller quantity of air than this, they might have a velocity of only 10 feet per second, and a mixture which would light-back. But if they turned the air on first (say, 20 cubic feet), through the burner, and then turned the hydrogen on till they got the right proportion, the burner did not light-back. He simply got the velocity first. Unfortunately when he got to this his time was up, as he had to come to town. Further experiment should include a modification of the mantle as well as the burner; and this was very desirable. It should also include experiments on the lines referred to by Professor Bone in his experiments on marsh gas. It might be difficult to get marsh gas on a large scale in a fair degree of purity, but at any rate they could get a mixture of hydrogen and marsh gas. This work, if carried on still further, would help them considerably in deciding as to what they ought to aim at in carbonization, which, after all, was the foundation of their work as gas manufacturers.

Mr. James Paterson (Redhill) said it struck him in listening to the paper that to a very large extent Mr. Forshaw was rather testing the mantle than the gas he had had under observation. When he looked at the long pencil-like flame of hydrogen, it struck him very forcibly that in using an ordinary mantle on a burner with such a flame, he was not getting combustion of the gas on the mantle itself. Of course, they understood that with these conditions it was an artificial experiment conducted on scientific lines; and it was very possible that better results would be obtained in illuminating effect if a mantle were used which was more nearly the shape of the long flame. He would suggest this point for future investigation by Mr. Forshaw or his successor. With regard to the use of cones, he had always been under the impression that the effect of putting a cold body into a flame was to act as an impediment to combustion, rather than to improve it; and he failed to see in the paper any evidence of the quickening of combustion which was referred to. It seemed contrary to their ideas that putting a black body in the middle of a flame would improve combustion. Furthermore, there must be the cooling effect of the body. Perhaps different results might have been obtained if the cone had been made hollow, of a very thin substance, so as to prevent absorption of the heat of the flame as far as possible. The effect of the cone seemed to be to throw the flame out on to the mantle. They were not really testing the flame and its luminosity under comparable conditions, but were throwing the flame out—increasing the luminosity at a certain point, as was shown by the diagrams of the appearance of the flame. The flame was put on the mantle; but it came out at the top, and the illuminating effect was lost—showing that the end to be attained was combustion of the gas on the mantle, or just inside, throwing the highest heat zone on the surface of the mantle. He hoped further experiments would be carried out to elucidate some of these difficult points.

Mr. Forshaw said that he did not know that he could reply in detail to all the criticisms; but he was extremely gratified to hear M. Sainte-Claire Deville's letter, because it was an honour to be noticed by anyone so distinguished in the profession. He indicated in his letter that the paper had not put forward anything contradictory to his conclusions; but he (the speaker) would point out that M. Sainte-Claire Deville's conclusion was simply that the illuminating power of a mantle was proportional to the calorific value of the gas used. The result of his experiments with hydrogen and carbon monoxide simply showed that, for an advantage of 13 per cent. in calorific value, carbon monoxide had an advantage of 48 per cent. in illuminating value in a mantle. He quite admitted M. Sainte-Claire's contention that the variation of the illuminating value of a mantle would be in the same direction as the calorific value; but he did not admit that it was proportional to it. With regard to the flame-temperature, he did not take observations. It was rather a difficult matter to do. If one used a thermojunction, it took a lot of time. The President had just informed him that he would be able to reply better to the criticisms which had been made if he cared to do so in writing; and he should take advantage of this opportunity.

A STUDY IN WORKING COSTS.

By HERBERT LEES, of Hexham.

A careful study of the published statistics relating to the accounts of gas undertakings can never fail to be interesting to the student of the economics of the gas industry; and it will always be instructive. It enables him to make comparison of his own working results with the best—if he does not happen to be so fortunate as to occupy that enviable position himself; and the introspection which this induces will generally lead to the strengthening of the weak places. To those engaged in the industry, it is well known that there is a commendable ambition on the part of engineers and managers of gas undertakings to sell gas as cheaply as possible. The outside critic would attribute this to stress of competition. But whatever may have been the sum-total of that influence, it cannot be gainsaid that, long before competition became serious, this ambition was very prevalent; and it was shown in the frequent reductions in the price of gas, as the outcome of improved working, and of the development of the consumption of gas for a variety of purposes.

Occasionally, some historic document comes to light, telling us of high prices for gas which are unknown to-day, even in remote and sparsely populated districts. We are, therefore, not justified in supposing, as is so often done, that the men responsible for the conduct of gas undertakings in the earlier stages of the industry's history were not imbued with a like spirit. We must not forget that when coal gas was introduced to the world as a means of illumination, it was in an age greatly affected by prejudice—if not by superstition. The "men of wisdom" had grave fears of what would happen if coal gas was stored in vessels such as we now know as gasholders. The ignorance which prompted these fears was not easily dissipated; and we cannot say that even now it has been entirely removed. This prejudice made their task very difficult; and that they were able to do so well says much for their energy and determination, as well as for the usefulness of the commodity they produced and sold.

The financial aspect of the gas engineer's work has received frequent reference in Presidential Addresses, and notably in recent years by Mr. D. Irving in his address to the Institution in 1905. If to any extent the author should trespass on ground previously covered either by that admirable address or by other writers, his excuse must be that only occasionally has the subject been presented as one for discussion, in which form it is likely to elicit a wider range of opinion which cannot be otherwise than advantageous; and if he should be guilty of any errors or false deductions, the subsequent discussion will no doubt correct them.

In a study of working costs, every phase of the conduct of a gas undertaking must be considered; for the ultimate result, as shown in the price of gas, depends upon the efficiency of the work of every department. Thus the engineer, in constructing works with due economy, and so that the processes of manufacture can be carried on in the most economical manner; the works manager in controlling these processes so that the most can be got out of the raw materials at a minimum cost; and the distribution superintendent, in exercising that vigilance which will ensure that no unnecessary loss by leakage from mains and service pipes, or from defective meters, will take place—each contributes to the economical working of the concern. Nor does the responsibility end here; for the success of a gas undertaking cannot be secured without wise administration, which will embrace the most efficient methods of dealing with, and educating, the public whose patronage it seeks.

It is good for the engineer not only to make comparison of his own with another's work, but also to carefully note the progress of his own undertaking from year to year; and what is good for the individual in this respect cannot be otherwise than beneficial if applied over a wider area. For that purpose, the author has had recourse to "Field's Analysis." In the earliest years of that useful publication, the accounts of the Metropolitan Gas Companies only were dealt with. Subsequently the Suburban Companies were added; and in 1883 it was further enlarged by the inclusion of representative Provincial undertakings under the administration of companies and corporations. Although there has been some change in the particular undertakings included, the average figures for each section have been taken.

It may be urged that there is danger in dealing with averages. That, of course, depends on how they are applied. The first object contemplated by the author is to ascertain what progress has been made as the result of improved methods of manufacture during the last 25 or 30 years. It is sometimes said—with more imagination than truth—that the methods of manufacture and purification of gas have not changed. It would be more correct to say that the principles involved are the same, but great advances in the application of those principles have been made. The author is not in a position to affirm that all the undertakings whose accounts are dealt with in "Field's Analysis" have brought their works up to date; but they may be accepted as representative undertakings, and they serve as an index of the progress made.

Fuel Account.—Appended to this paper is a table (Appendix A) giving the analyses of the accounts of those undertakings for the years 1878, 1883, 1888, 1893, 1898, 1903, and 1907, being intervals of five years with the exception of the last-named, which is the latest issue at the time of writing. The Metropolitan Gas Companies only are included in the 1878 column; and this is interesting as showing the working costs before the introduction of gaseous firing. The figures indicate that, on the whole, the fuel account of the Metropolitan undertakings was not extravagant for that period; in fact, it was as good as that of the Provincial undertakings 25 years later. This item of fuel account is, perhaps, the most disappointing of any of the figures given; and it is at the same time the most difficult to state accurately. This is shown by a comparison of one of the undertakings under review, with the "Gas World Analysis" of the same accounts. "Field's Analysis" states the coke made at 12·03 cwt. per ton of coal carbonized, of which 1·53 cwt. was used for fuel—being 13 per cent. on the coke made; while the "Gas World Analysis" figures show 13·4 cwt. of coke and breeze available for sale. These differences are very conflicting, and make it difficult to formulate any reliable comparisons on this point. But assuming that the same method of calculation has been adopted throughout by the compilers of "Field's Analysis," there is shown the very satisfactory figures in individual cases of 13, 14, 15, 16, and 19 per cent. of coke made used for fuel. But it must be stated that in 1883 two undertakings were as low as 15 per cent., which results have not been consistently maintained by those undertakings in subsequent years. Two of the undertakings showing a fuel account of 55 and 41 per cent. of the coke made in 1883, have in 1907 reduced these figures to 24 and 27 per cent. respectively. There is evidence of progress in the direction of fuel economy, which must always be regarded as one of the essential features of good retort-house practice; and this will surely become more general.

Make per Ton.—The second advantage to be derived from gaseous firing is an increased yield of gas per ton of coal carbonized. The introduction of the manufacture of carburetted water gas seemed to disturb the calculation of this item for a time; and for some years it did not appear in "Field's Analysis." But it has recently reappeared in an appendix, and is based upon the coal gas made only. The figures of the accounts given in Appendix "A" are—

TABLE I.—*Gas Made per Ton of Coal Carbonized.*

—	1883.	1907.
	Cubic Feet.	Cubic Feet.
Metropolitan Companies	10,275	10,885
Suburban ,,	10,213	11,169
Provincial ,,	10,113	10,457
,, Corporations	9,758	10,827

These figures show substantial progress; and the best results of 1883 and the best of 1907 are about relatively comparable with them. There is, however, a marked advance in some individual cases—one undertaking showing 9141 cubic feet per ton in 1883 and 10,753 cubic feet in 1907; another 9120 and 11,043 cubic feet per ton respectively. Some of the progress made under this heading must be attributed to other causes than that of carbonizing temperatures—such as retort-house governors, light liquor seals, "dry" mains, and better knowledge of carbonizing principles; and perhaps the advantage of a carburetted water gas plant, or some other enriching medium, makes it practicable to extract an abnormal amount of gas from the coal in some instances. Be that as it may, several undertakings can now show a "make per ton" of upwards of 12,000 cubic feet; and no one cares to speak of his results if the figure does not materially exceed 11,000 cubic feet.

These higher figures are not yet general, and the advantage to be gained thereby may be counted among the "reserve forces" of the industry.

Coal and Residuals.—The cost of raw materials, and the prices of residual products will always be subject to market fluctuations and influenced by local circumstances; but the income from these products is dependent, in some measure, upon the working results. Economy in fuel is reflected in the coke sales; while the extraction of a maximum amount of ammonia from the gas—and subsequently from the liquor—and its conversion into sulphate of ammonia, is a determining factor and one over which there is some control. Coke usually follows coal in its fluctuations in price; and to some extent makes good the loss sustained by an undertaking as a result of higher coal prices. This same effect is noticeable in those undertakings near to, and distant from, the coal-fields respectively, with the result that the difference in prices is partly corrected thereby. This, however, has its limitations; and undertakings at a great distance from the source of supply (especially those dependent upon the railways for carriage) are at a great disadvantage. This is shown in Appendix A in the case of Suburban Companies; and the Provincial undertakings far removed from the coal-fields are likewise disadvantageously placed.

Working Expenses.—The working expenses have not on the whole shown any appreciable reduction; and in some cases there is an increase. The following figures taken from Appendix A show the position in 1883 and 1907 respectively per 1000 cubic feet of gas sold:—

TABLE II.—*Total Working Expenses per* 1000 *Cubic Feet of Gas Sold.*

—	1883.	1907.	Increase or Decrease.
	d.	d.	d.
Metropolitan Companies . . .	14·79	16·24	+1·45
Suburban ,, . . .	17·52	17·37	−0·15
Provincial ,, . . .	13·48	12·35	−1·13
,, Corporations. . . .	12·00	12·50	+0·50

The rate of wages is an important factor in these costs. The advances made in the period under review have probably been not less than 30 per cent. in the aggregate; and the economies effected by the introduction of machinery have been largely counteracted thereby. But this is not the only disturbing factor. There has been a change in the incidence of the charges. The cost of manufacture (apart from coal) shows an almost continuous decline; and in the final result the figures per 1000 cubic feet of gas sold are substantially less than in the earliest year taken, as the following statement shows:—

TABLE III.—*Manufacturing Charges (Exclusive of Coal) per* 1000 *Cubic Feet of Gas Sold.*

—	1883.	1907.	Reduction.
	d.	d.	d.
Metropolitan Companies . . .	9·47	7·12	2·35
Suburban ,, . . .	10·42	7·31	3·11
Provincial ,, . . .	8·28	6·52	1·76
,, Corporations . . .	7·74	7·02	0·72

The reduction of these charges in the case of the Metropolitan and Suburban Companies forms a substantial proportion of the total; and although the Provincial undertakings show smaller reductions, they have a slight advantage in the total costs in 1907. There were, of course, fluctuations from year to year; and it will be noticed that, between 1888 and 1893, there was a marked increase in these costs, which however had almost disappeared by 1898. The cause of this increase will, doubtless, be found in the disturbed state of the labour market of that period. Being followed, as it was, by the introduction of machinery, the increased cost of manufacture was practically overtaken in the latter year. Since then the reduction of manufacturing charges appears to have assumed a permanent character. That this is very largely due to the use of machinery and new methods of carbonization is evident from the fact that carbonizing wages show a substantial proportion of the reduced costs. It is very gratifying that the introduction of additional machinery has not added to the cost of "wear and tear." Even this item is less than formerly. Purification, in the last year dealt with, shows a lessened cost in the Metropolitan and Suburban gas undertakings; the Provincial Companies exhibit great regularity; while the Provincial Corporations show more fluctuation in these figures. The abolition of the sulphur clauses is not likely to have any substantial effect upon the Provincial undertakings, as many of the Companies and all the Corporations were previously exempt. Moreover, freedom from legal restrictions should not, and probably will not, lead to a lax policy in regard to purification. There is so little to be gained, and there is much to be lost, if the public should form a prejudice against the use of gas on account of any increase, or supposed increase, in the quantity of sulphur remaining in the gas.

Distribution Charges.—When the great changes that have been effected in the distribution department of a gas undertaking are taken into account, it will not be surprising to find that the economies gained in other directions are cancelled by increased expenditure in this department. In each section of the accounts under review, the increase is considerable; but in the Metropolitan and Suburban Companies—especially the latter—it reaches a very high figure. The method of dealing with slot installations will materially affect this figure in particular accounts, and will probably in some measure explain the discrepancies which appear between different undertakings.

Rates and Taxes.—This item shows an increase of nearly 50 per cent. for the Metropolitan Companies; the Suburban and Provincial Companies have maintained a very regular figure throughout; and the Provincial Corporations exhibit an upward tendency which amounts to an increase of 40 per cent. in a comparison of 1907 with 1883. This is somewhat surprising, inasmuch as it is supposed that, when a Corporation owns the gas undertaking and receives substantial sums therefrom in aid of the rates, the rates are less than in other towns where this does not obtain. These figures suggest that this is not the case.

Management, Etc.—The costs under this head do not greatly vary from year to year; but there is a tendency to a reduction. Law, bad debts, and other charges are not such as to seriously affect the total working costs.

Net Cost in Holder.—The net cost of gas in holder per 1000 cubic feet sold (including the net cost of coal for manufacturing charges) is shown in the following statement:—

TABLE IV.—*Net Cost of Gas in Holder per* 1000 *Cubic Feet of Gas Sold.*

—	1883.	1907.	Increase or Decrease.
	d.	d.	d.
Metropolitan Companies . . .	15·57	12·57	−3·00
Suburban ,, . . .	18·98	16·04	−2·94
Provincial ,, . . .	15·04	11·32	−3·72
,, Corporations	11·13	11·89	+0·76

The total economies effected up to the point of delivery into the holder are here shown; and it will be seen in the next table that other charges—principally for distribution—have nullified the advantage thus gained. The total cost for net coal and working expenses per 1000 cubic feet of gas sold is as follows:—

TABLE V.—*Net Coal and Working Expenses per* 1000 *Cubic Feet of Gas Sold.*

—	1883.	1907.	Increase or Decrease.
	d.	d.	d.
Metropolitan Companies . . .	20·89	21 69	+0·80
Suburban ,, . . .	26·08	26·10	+0·02
Provincial ,, . . .	20·24	17·15	−3·09
,, Corporations	15·39	17·37	+1·98

The final result of 24 years' development shows that there is a slight increase in the cost of gas per 1000 cubic feet sold by the Metropolitan and Suburban Companies; the Provincial Companies show the substantial reduction of 3·09d., and the Corporations an increase of 1·98d. It must not be overlooked, however, that the earlier year was in the period when tar and sulphate of ammonia realized very high prices, which for the four sections amounted to 2·15d., 2·76d., 2·35d., and 3·61d. respectively, in excess of the latter year. While this is a disturbing factor in the comparison of total costs and of net cost of gas in holder, it does not influence the other figures; and as the prices of those days are not

likely to recur, it must be ignored in any considerations and deductions as to the future.

Capital Charges.—The possibilities of reduced prices for gas are not exhausted in the figures shown in the revenue account; and although the net result of the comparisons may from that standpoint be somewhat disappointing, there remains a further field for exploitation—namely, that of capital charges. There has been substantial progress made in the reduction of these charges during the period covered by this survey, as the following figures indicate:—

TABLE VI.—*Capital Charges per* 1000 *Cubic Feet of Gas Sold.*

—	1883.	1907.	Reduction.
	d.	d.	d.
Metropolitan Companies . . .	15·07	10·40	4·67
Suburban ,, . . .	15·18	9·00	6·18
Provincial ,, . . .	10·79	7·79	3·00
,, Corporations . . .	10·16	6·29	3·87

In a paper read before the North of England Gas Managers' Association in 1907, the author dealt with this aspect of the question as it affected a particular undertaking; and the factors which in that instance operated in bringing about a great reduction of these charges are such as obtain in other undertakings—viz., (*a*) the development of the use of gas for a variety of purposes in addition to lighting, thus inducing day consumption, which is specially valuable during the summer months, and (*b*) the lower rates at which capital can now be obtained by gas companies.

To complete the comparison, a further table is necessary, showing the net gas rental per 1000 cubic feet sold, which is as follows:—

TABLE VII.—*Net Gas Rental per* 1000 *Cubic Feet of Gas Sold.*

—	1883.	1907.	Reduction.
	d.	d.	d.
Metropolitan Companies . . .	36·75	30·34	6·43
Suburban ,, . . .	41·66	31·83	9·83
Provincial ,, . . .	30·39	22·77	7·62
,, Corporations . . .	29·30	26·16	3·14

There is, therefore, as a final result, a substantial reduction in the prices charged for gas in each of the sections; and so far as these undertakings are representative of the bulk throughout the country, there has been real progress. If this is least marked in the case of the Corporation undertakings, it must not be overlooked that they occupied a somewhat better position in 1883 than any of the other sections. When this has been said, however, something still remains to be explained. In the raising of capital, they have occupied a very advantageous position; but the difference is becoming less, and while the Provincial Companies show a steady reduction, the Corporations' charges appear to be on the increase. One of the undertakings included in the statistics increased its capital charges from 4·47d. to 7·41d. per 1000 cubic feet of gas sold between 1900 and 1907. The cause of this was fully dealt with in the Presidential Address of Mr. Charles Wood in 1906; and it serves to show—what the author endeavoured to demonstrate in the paper that he read before the Gas Institute in 1897—that the advantages of municipalization do not apply now as they did in the years when gas companies paid heavily for their capital.

Every movement has its pioneers, and average success is not the maximum of achievement. It is desirable, therefore, to look at this question from the standpoint of those who have gained greatest success. Especially should this point of view be taken in forming ideals for the future. Only the best are good enough for "models," and in a search for examples a wider range of gas undertakings has been taken. For this purpose, the "Gas World Analyses of Accounts" has been consulted. It is, perhaps, assuming a serious responsibility to make choice of examples for this purpose; but it must be understood that there are many excellent records which could not be conveniently included in the list.

Appendix B gives the analyses of the accounts of ten undertakings in different parts of England, each being, in many respects, a model in its own district, and some will be recognized as being in the very forefront of economical working.

The cost of coal is in some measure an indication of the distance of the works from the coal supply; and in any comparison this should be taken into account. The returns from residual products are not unsatisfactory in any instance, and in some they are exceptionally good. The proportions from ammonia are high in two or three undertakings—"F" undertaking showing the highest yield from this source of any of the English undertakings whose accounts are included in the "Gas World Analyses."

Purification costs in six cases are under one-tenth of a penny, and in two are as low as one-fiftieth of a penny per 1000 cubic feet of gas sold. There are several explanations to be given for this low cost of purification, not the least important of which is in having purifiers of ample capacity. It would be very instructive if, in the subsequent discussion, information was given by engineers who are in a favourable position in regard to this item. There are many who could speak from the opposite standpoint, and who would be attentive listeners to hints on cheap purification.

The item of salaries under manufacturing is somewhat irregularly dealt with; and in the case of "F" undertaking no charge is made in the published accounts, but it is included in management charges. The author has taken the liberty of estimating this at 0·5d. per 1000 cubic feet of gas sold. He has transferred that amount from management charges to salaries under manufacturing charges; and having regard to the excellent record of the undertaking no one could say that the estimate of the value of the engineer and his staff is over-stated. This transference affects the cost of gas in holder.

Carbonizing wages vary considerably; but some of the undertakings do not use stoking machinery, and others do so in part only. The lowest figure of 1·07d. per 1000 cubic feet of gas sold is that of an undertaking with a "make" of about 200 million cubic feet per annum; and the result is so exceptionally good that the author felt it would add great interest to his paper if the reasons for this could be given. He therefore entered into communication with the engineer, who very kindly replied as follows:

> **We attribute our low cost of carbonizing to the adoption of the De Brouwer charging and discharging machinery, a coke conveyor, and eight-hour charges. The cost in 1907-8 was 1·07d., and in 1908-9 1·10d. per 1000 cubic feet of gas sold. The carbonizing wages include stokers and enginemen. We do not employ separate men for furnaces and pipe-jumping; in fact, we have not had any trouble with stopped pipes since we commenced to fill our retorts and work eight-hour charges. We have worked in this way over two years, and certainly would not go back to six-hour charges. We should much prefer to lengthen the duration, if the size of the retorts permitted.**

This statement is interesting, as showing the trend of modern carbonizing practice as well as for its value in regard to the results obtained; and the author acknowledges his indebtedness to the engineer of the works for the information.

By the courtesy of an engineer of a works not included in the list in Appendix B, the author is enabled to give some further figures which are interesting as showing the progress made in the reduction in carbonizing charges. Before the introduction of inclined retorts at the station in question, "firemen's wages" amounted to 3·583d. per 1000 cubic feet of gas made. The erection of inclined benches extended over a few years with a gradually decreasing wages bill, as shown in the following statement:—

With one inclined bench, the cost per 1000 feet made was						3·418d.
,, two	,,	benches,	,,	,,	,,	2·448
,, three	,,	,,	,,	,,	,,	2·010
,, four	,,	,,	,,	,,	,,	1·825

Showing a saving of 1·758d. per 1000 cubic feet of gas made as a result of the introduction of "inclines" throughout, and amounting to £3612 on the gas made per annum at the station.

The extra cost over the provision of hand-fired benches amounted to £14,000; and the saving effected provides 5 per cent. for repairs *plus* 20 per cent. as a return for the outlay. At another station of the same undertaking, where stoking machinery has been installed, on a make of 1½ millions per day, the cost of all carbonizing wages—from coal into the breaker to coke out of retorts, including power-house and motor man, machine man, lid man on machine side, lid man on discharge side, cellar man, hopper man, and foreman—is 1d. per 1000 cubic feet of gas made, or 11d. per ton of coal carbonized. At a third station, with the same type of machine with a full installation on a daily make of 2½ millions, the cost will be down to 8d. per ton of coal

APPENDIX A.—ANALYSES OF ACCOUNTS EXTRACTED FROM "FIELD'S ANALYSIS."

—	Metropolitan Companies.													
	1878.		1883.		1888.		1893.		1898.		1903.		1907.	
	d.	d.	d.	d.	d.	d.	d.	d.	d.	d.	d.	d.	d.	d.
Coal	—	19·58	—	17·59	—	14·70	—	15·51	—	14·03	—	14·71	—	15·27
Less residuals:—														
Coke and breeze	6·65	—	6·18	—	6·16	—	6·54	—	5·87	—	6·88	—	6·66	—
Tar	1·95	—	2·55	—	1·59	—	1·65	—	1·05	—	1·57	—	1·12	—
Ammonia	2·37	10·97	2·76	11·49	2·04	9·79	1·90	10·09	1·53	8·45	1·96	10·41	2·04	9·82
Net coal	—	8·61	—	6·10	—	4·91	—	5·42	—	5·58	—	4·30	—	5·45
Manufacturing charges:—														
Purification	1·03	—	·87	—	·71	—	·79	—	·80	—	1·06	—	·45	—
Salaries	·45	—	·39	—	·32	—	·34	—	·35	—	·40	—	·40	—
Wages (carbonizing)	3·83	—	3·49	—	3·34	—	4·13	—	3·67	—	3·01	—	2·27	—
Wear and tear	5·59	10·90	4·72	9·47	3·16	7·53	4·24	9·50	3·64	8·46	4·35	8·82	4·00	7·12
Net cost of gas in holder	—	19·51	—	15·57	—	12·44	—	14·92	—	14·04	—	13·12	—	12·57
Distribution charges	—	2·39	—	1·85	—	1·75	—	2·39	—	2·80	—	3·53	—	4·50
Rates and taxes	—	1·56	—	1·70	—	1·95	—	2·12	—	2·23	—	2·64	—	2·52
Management	—	1·44	—	1·19	—	·93	—	·90	—	·98	—	1·08	—	1·12
Law, bad debts, and other charges	—	·60	—	·58	—	·55	—	·86	—	·61	—	·90	—	·98
Net coal and working expenses	—	25·50	—	20·89	—	17·62	—	21·19	—	20·66	—	21·27	—	21·69
Net gas rental	41·44	—	36·75	—	31·61	—	34·04	—	31·92	—	31·88	—	30·34	—
Meter and stove rentals and other receipts	·22	41·66	−·13	36·62	·87	32·48	1·09	35·13	·91	32·83	1·35	33·23	2·54	32·88
Gross profit	—	16 16	—	15·73	—	14·86	—	13·94	—	12·17	—	11·96	—	11·19
Capital charges	—	15·24	—	15·07	—	13·70	—	13·15	—	11·59	—	10·82	—	10·40
Surplus or deficit	S	·92	S	·66	S	1·16	S	·79	S	·58	S	1·14	S	·79
Some Working Results.														
Gas made per ton of coal carbonized cub. ft.	10,181		10,275		10,356		10,191		—		—		10,885	
Gas sold per mile of main ,,	—		—		8,664,000		8,976,000		10,178,000		10,051,000		10,327,000	
Gas unaccounted for—per cent. on make	5·56		5·99		5·63		5·24		4·92		4·35		4·83	
Coke used for fuel—per cent. on make	27		24		22		25		22		23		24	

—	Suburban Companies.											
	1883.		1888.		1893.		1898.		1903.		1907.	
	d.	d.	d.	d.	d.	d.	d.	d.	d.	d.	d.	d.
Coal	—	20·36	—	17·91	—	18·48	—	16·08	—	17·01	—	16·95
Less residuals—												
Coke and breeze	6·95	—	6·96	—	7·17	—	5·82	—	6·28	—	6·04	—
Tar	2·61	—	1·08	—	1·07	—	1·06	—	1·27	—	·94	—
Ammonia	2·24	11·80	1·43	9·47	1·74	9·98	1·15	8·03	1·34	8·89	1·24	8·22
Net Coal	—	8·56	—	8·44	—	8·50	—	8·05	—	8·12	—	8·73
Manufacturing charges:—												
Purification	·77	—	·65	—	·79	—	·80	—	·80	—	·38	—
Salaries	·74	—	·61	—	·57	—	·44	—	·48	—	·46	—
Wages (carbonizing)	4·03	—	3·53	—	4·34	—	3·44	—	2·84	—	2·25	—
Wear and tear	4·88	10·42	3·74	8·53	4·06	9·76	4·04	8·72	4·36	8·48	4·22	7·31
Net cost of gas in holder	—	18·98	—	16·97	—	18·26	—	16·77	—	16·60	—	16·04
Distribution charges	—	1·80	—	2·17	—	2·46	—	3·95	—	5·18	—	6·16
Rates and taxes	—	1·97	—	1·84	—	1·76	—	1·83	—	1·83	—	1·74
Management	—	2·88	—	2·34	—	2·08	—	1·85	—	1·75	—	1·70
Law, bad debts, and other charges	—	·45	—	·60	—	·45	—	·39	—	·60	—	·46
Net coal and working expenses	—	26·08	—	23·92	—	25·01	—	24·79	—	25·96	—	26·10
Net gas rental	41·66	—	36·75	—	36·50	—	33·91	—	33·81	—	31·83	—
Meter and stove rentals and other receipts	·41	42·07	1·18	37·93	1·33	37·83	2·02	35·93	2·76	36·57	3·61	35·44
Gross profit	—	15·99	—	14·01	—	12·82	—	11·14	—	10·61	—	9·34
Capital charges	—	15·18	—	12·94	—	12·21	—	10·55	—	9·57	—	9·00
Surplus or deficit	S	·81	S	1·07	S	·61	S	·59	S	1·04	S	·34
Some Working Results.												
Gas made per ton of coal carbonized cub. ft.	10,213		10,407		10,220		—		—		11,169	
Gas sold per mile of main ,,	—		3,507,000		3,982,000		4,694,000		5,470,000		5,977,000	
Gas unaccounted for—per cent. on make	5·67		5·23		5·95		5·24		5·58		5·50	
Coke used for fuel—per cent. on make	24		23		26		25		24		21	

carbonized, or 0·7d. per 1000 cubic feet of gas made. These are excellent results, and promise well for the possibilities of further economy in gas manufacture to undertakings able to take advantage of the latest methods of carbonizing. It will be remembered that Mr. A. F. P. Hayman, in his paper on "Dessau Vertical Retorts" read at last year's meeting, stated the cost of carbonizing wages for that system at 5d. per ton, as against 9·4d. for "inclines" at Berlin.

It is probably on the works that further economies will be effected; and as carbonizing methods are at present in a state of transition, it is not desirable to make any prophecy of the extent of these economies. The present, however, is not an inopportune time for marking progress; and this paper is an attempt in that direction. The result is not at all discouraging, and the prospects are distinctly hopeful. It is not possible for each works to be adapted to new conditions as soon as new methods of manufacture are available. Capital already invested cannot be disposed of by the stroke of a pen; but as opportunity for renewal arises, the changes will be made, and eventually the lower costs named will become the rule rather than the exception.

Distribution charges do not seem to offer any immediate promise of substantial reduction. The increase consequent on the introduction of slot meter installations has in many

APPENDIX A (*continued*).—ANALYSES OF ACCOUNTS EXTRACTED FROM "FIELD'S ANALYSIS."

PROVINCIAL COMPANIES.

—	1883.		1888.		1893.		1898.		1903.		1907.	
	d.	d.	d.	d.	d.	d.	d.	d.	d.	d.	d.	d.
Coal	—	15·88	—	13·25	—	17·05	—	12·24	—	13·34	—	13·78
Less residuals :—												
Coke and breeze	3·73	—	3·42	—	4·27	—	4·60	—	5·60	—	5·94	—
Tar	3·04	—	1·38	—	1·67	—	1·27	—	1·55	—	1·14	—
Ammonia	2·35	9·12	1·97	6·77	2·08	8·02	1·36	7·23	1·98	9·13	1·90	8·98
Net coal	—	6·76	—	6·48	—	9·03	—	5·01	—	4·21	—	4·80
Manufacturing charges :—												
Purification	·52	—	·61	—	·68	—	·63	—	·64	—	·65	—
Salaries	·54	—	·45	—	·48	—	·41	—	·35	—	·37	—
Wages (carbonizing)	3·64	—	3·32	—	4·12	—	3·74	—	3·15	—	2·63	—
Wear and tear	3·58	8·28	3·03	7·41	3·28	8·56	3·17	7·95	3·37	7·51	2·87	6·52
Net cost of gas in holder	—	15·04	—	13·89	—	17·59	—	12·96	—	11·72	—	11·32
Distribution charges	—	1·98	—	1·99	—	1·92	—	2·31	—	3·14	—	3·22
Rates and taxes	—	1·24	—	1·21	—	1·26	—	1·30	—	1·38	—	1·25
Management	—	1·72	—	1·45	—	1·41	—	1·23	—	1·20	—	1·20
Law, bad debts, and other charges	—	·26	—	·14	—	·16	—	·16	—	·24	—	·16
Net coal and working expenses	—	20·24	—	18·68	—	22 31	—	17·96	—	17·68	—	17·15
Net gas rental	30·39	—	28·46	—	29·80	—	24·67	—	25·32	—	22·77	—
Meter and stove rentals and other receipts	·65	31·04	1·15	29·61	1·24	31·04	1·40	26·07	1·82	27·14	2·01	24·78
Gross profit	—	10·80	—	10·93	—	8·70	—	8·11	—	9·46	—	7·63
Capital charges	—	10·79	—	9·62	—	9·41	—	8·32	—	7·76	—	7·77
Surplus or deficit	S	·01	S	1·31	D	·71	D	·21	S	1·70	D	·14
Some Working Results.												
Gas made per ton of coal carbonized cub. ft.	10,113		10,579		10,294		—		—		10,457	
Gas sold per mile of main ,,	—		3,632,000		4,706,000		5,444,000		5,629,000		5,667,000	
Gas unaccounted for—per cent. on make	7·71		6·88		6·78		6·46		6·87		6·34	
Coal used for fuel—per cent. on make	35		35		33		26		27		25	

PROVINCIAL CORPORATIONS.

—	1883.		1888.		1893.		1898.		1903.		1907.	
	d.	d.	d.	d.	d.	d.	d.	d.	d.	d.	d.	d.
Coal	—	13·59	—	12·29	—	15·78	—	12·60	—	14·36	—	12·54
Less residuals :—												
Coke and breeze	3·05	—	2·55	—	3·48	—	2·70	—	4·29	—	4·13	—
Tar	3·32	—	1·43	—	1·45	—	1·54	—	1·80	—	1·55	—
Ammonia	3·83	10·20	1·84	5·82	2·09	7·02	1·45	5·69	2·04	8·13	1·99	7·67
Net coal	—	3·39	—	6·47	—	8·76	—	6·91	—	6·23	—	4·87
Manufacturing charges :—												
Purification	·20	—	·33	—	·55	—	·45	—	·61	—	·49	—
Salaries	·36	—	·27	—	·26	—	·25	—	·27	—	·29	—
Wages (carbonizing)	3·39	—	3·08	—	3·67	—	3·12	—	2·94	—	2·72	—
Wear and tear	3·79	7·74	3·38	7·06	3·76	8·24	4·07	7·89	4·22	8·04	3·52	7·02
Net cost of gas in holder	—	11·13	—	13·53	—	17·00	—	14·80	—	14·27	—	11·89
Distribution charges	—	1·82	—	2·07	—	1·97	—	2·31	—	2·87	—	2·68
Rates and taxes	—	1·38	—	1·29	—	1·43	—	1·58	—	1·91	—	1·94
Management	—	·83	—	·76	—	·76	—	·74	—	·73	—	·73
Law, bad debts, and other charges	—	·23	—	·13	—	·10	—	·12	—	·12	—	·13
Net coal and working expenses	—	15·39	—	17·78	—	21·26	—	19·55	—	19·90	—	17·37
Net gas rental	29·30	—	28·13	—	29·04	—	27·17	—	29·35	—	26·16	—
Meter and stove rentals and other receipts	·70	30·00	1·00	29·13	·84	29·88	·54	27·71	·54	29·89	·44	26·60
Gross profit	—	14·61	—	11·35	—	8·62	—	8·16	—	9·99	—	9·23
Capital charges	—	10·16	—	8·07	—	6·02	—	5·26	—	6·96	—	6·29
Surplus or deficit	S	4·45	S	3·28	S	2·60	S	2·90	S	3·03	S	2·94
Some Working Results.												
Gas made per ton of coal carbonized cub. ft.	9,758		10,165		9,946		—		—		10,827	
Gas sold per mile of main ,,	—		4,395,000		5,309,000		5,795,000		6,023,000		5,465,000	
Gas unaccounted for, per cent. on make	7·03		7·07		5·32		5·71		5·40		5·74	
Coke used for fuel, per cent. on make	33		35		31		31		29		26	

cases reached its maximum; and some relief is, therefore, possible in that direction. But the adoption of high-pressure distribution will probably tend to increase rather than decrease these charges. On the other hand, capital charges on mains should be less; and the use of gas for special purposes and for high-pressure lighting without the use of pressure-raising machinery on the consumer's premises, is an advantage of considerable value. The prospects of extending mains into outlying districts is enhanced by the possibilities of this system.

It will be observed that the most successful undertakings are not those with the highest "make per ton." This remark must not be interpreted as deprecating a high "make per ton;" but it will be seen that it is not the only element which makes for success. The quality and price of coal must be considered conjointly; and if the one with a low yield of gas per ton works out the most economical, it should be chosen. That this is not always done may to some extent be attributed to the fact that members of Gas Committees and Boards of Directors read of what is being done at works other than their own, and cannot always understand why their engineer does not do as well with the coal at his disposal. Consequently, there is a temptation to recommend the use of the better quality of coal,

APPENDIX B.—ANALYSES OF ACCOUNTS OF UNDERTAKINGS EXTRACTED FROM THE "GAS WORLD ANALYSES" FOR 1907-8.

—	A.		B.		C.		D.		E.		F.		G.		H.		I.		J.	
	d.	d.	d.	d.	d.	d.	d.	d.	d.	d.	d.	d.	d.	d.	d.	d.	d.	d.	d.	d.
Coal	—	9·96	—	12·79	—	15·63	—	15·01	—	11·36	—	12·54	—	11·21	—	11·23	—	14·16	—	15·71
Less residuals—																				
Coke and breeze	6·26	—	6·90	—	7·23	—	7·38	—	6·05	—	6·42	—	6·15	—	6·27	—	6·24	—	7·11	—
Tar	1·43	—	·95	—	1·33	—	4·29	—	1·52	—	1·13	—	1·70	—	1·61	—	·95	—	1·06	—
Ammonia	2·68	10·37	1·80	9·65	2·40	10·96		11·67	1·87	9·44	3·09	10·64	1·51	9·36	2·08	9·96	1·84	9·03	1·45	9·62
Net coal		cr. ·41	—	3·14	—	4·67	—	3·34	—	1·92	—	1·90	—	1·85	—	1·27	—	5·13	—	6·09
Manufacturing charges—																				
Purification	·31	—	·98	—	·48	—	·08	—	·02	—	·02	—	·08	—	·06	—	·07	—	·43	—
Salaries	·27	—	·41	—	·54	—	·48	—	·82	—	·50	—	·35	—	·57	—	·49	—	·13	—
Wages (carbonizing)	2·47	—	2·94	—	2·27	—	1·07	—	1·72	—	2·99	—	2·12	—	1·83	—	2·02	—	2·43	—
Wear and tear	2 91	5·96	2·37	6·70	3·51	6·80	2·60	4·23	2·95	5·51	1·75	5·26	3·97	6·52	3·29	5·75	3·17	5·75	4·13	7·12
Net cost of gas in holder	—	5·55	—	9·84	—	11·47	—	7·57	—	7·43	—	7·16	—	8·37	—	7·02	—	10·88	—	13·21
Distribution charges	—	1·86	—	1·90	—	2·48	—	1·59	—	1·97	—	2·07	—	5·64	—	2·12	—	3·47	—	3·71
Rates and taxes	—	1·35	—	·99	—	1·60	—	2·28	—	2·47	—	1·20	—	2·93	—	2·74	—	1·13	—	1·07
Management	—	·88	—	1·27	—	1·25	—	·41	—	·81	—	1·37	—	1·06	—	·70	—	1·35	—	1·48
Law, bad debts, and other charges	—	·50	—	·61	—	2·66	—	·03	—	·79	—	—	—	·69	—	1·75	—	1·60	—	1·92
Net coal and working expenses	—	10·14	—	14·61	—	19·46	—	11·88	—	13·47	—	11·80	—	18·69	—	14·33	—	18·43	—	21·39
Net gas rental	15·26	—	20·72	—	24·91	—	25·53	—	35·05	—	14·76	—	31·90	—	31·21	—	23·92	—	23·83	—
Meter and stove rental and other receipts	1·52	16·78	2·67	23·39	2·52	27·43	1·00	26·53	·08	35·13	2·33	17·09	1·96	33·86	·79	32·00	3·39	27·31	4·45	28·28
Gross profit	—	6·64	—	8·78	—	7·97	—	14·65	—	21·66	—	5·29	—	15·17	—	17·67	—	8·88	—	6·89
Capital charges	—	6·29	—	8·75	—	7·96	—	6·34	—	10·77	—	2·48	—	8·51	—	8·81	—	8·33	—	6·38
Surplus or deficit	S	·35	S	·03	S	·01	S	8·31	S	10·89	S	2·81	S	6·66	S	8·86	S	·55	S	·51
Some Working Results.																				
Gas made per ton of coal. cubic feet	10,579		11,055		10,762		10,306		12,328		9,792		12,129		11,149		10,212		10,809	
Gas sold per mile of main "	5,804,000		4,253,000		10,364,000		4,483,000		4,553,000		7,280,000		4,462,000		5,965,000		4,844,000		10,302,000	
Gas unaccounted for—per cent. on make	3·0		10·4		2·9		2·7		4 5		2·9		8·3		2·1		3·4		5·0	
Coke and breeze saleable per ton of coal . . . . cwt.	9		10		10·4		11·3		11·4		10·9		8·6		9·5		10·6		11·2	

though this may result in less economical working. The high yield is obtained, and everybody concerned is satisfied—not least the engineer, who has enhanced his reputation as a carbonizer, and taken a step forward towards a more lucrative appointment. It requires some courage on the part of an engineer to continue the use of a coal which does not show up well in the published carbonizing statistics, even though it is economical to do so.

The method of ascertaining the "make per ton" varies. The practice of correcting for temperature and pressure obtains in some works, and for temperature only in others; while it is probably correct to say that in the majority of works no corrections are made. To be scientifically accurate, the corrections should be made, and care should be exercised to maintain the water-line of the station-meter at its proper level. Attention to these matters would probably disturb the item of "unaccounted-for gas." But it is surely an advantage to have accurate knowledge of what is being done in each department.

There is another point of comparison that may perhaps be permitted—especially so, having regard to what has been happening in the Parliamentary Committee Rooms recently. It has frequently been stated that gas undertakings owned by local authorities sell gas much cheaper than do gas companies. Such a statement is based on figures that are not properly comparable. The Provincial Companies whose accounts appear in "Field's Analysis" are for the most part far removed from the coal-fields, while the Corporation undertakings are, with one exception, in close proximity thereto. Notwithstanding this advantage, however, the average net gas-rental of the Companies' undertakings was in 1907 less than those of the Corporations, by 3·39d. per 1000 cubic feet, while in 1903 the difference was 4·03d. in favour of the Companies. The surplus profits were higher in the case of the Corporations; and thus they were in a position to contribute something in aid of the rates. In 1907, the amount was 2·58d., and in 1903 it was 2·68d. per 1000 cubic feet sold, which sums do not make up the difference in the charge for gas. It is obvious, therefore, that these contributions from the gas profits to the rates are placing the Municipal consumer at a distinct disadvantage as compared with the Companies' customer; and it has already been pointed out that the rates do not appear to be lower in those towns.

This paper would not be complete without a further reference to the advantages the consumer of gas has derived as the result of the progress made during the past generation. The reduced price of gas is but a small proportion of his gains. Each cubic foot of gas consumed under modern conditions is, for power purposes, about three times its former value; for heating purposes, something approaching this may be claimed; while for lighting it is possible to get results varying from eight to twenty times that which was previously obtainable. These are great achievements; and if succeeding generations do equally well, or anything approaching thereto, there is little fear that gas will suffer in popularity.

RELATIVE CAPITAL ACCOUNTS OF GAS UNDERTAKINGS OWNED BY COMPANIES AND LOCAL AUTHORITIES.

By ARTHUR VALON, of London.

Comparisons are frequently made between company and local authority management of gas undertakings in regard to their capital expenditure, usually with reference to the difference between the capital raised per million cubic feet of gas sold as it appears in the Board of Trade returns. The bare figures as given in these returns are certainly startling; for the total capital raised per million cubic feet of gas sold by statutory gas companies is £822, while the total money borrowed by local authorities, after deducting sinking fund and loan repayments, amounts but to £457.

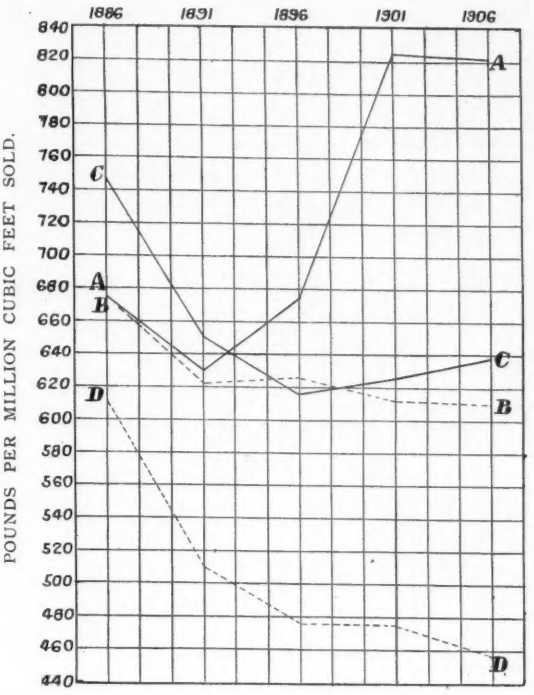
A very short examination of the details will, however, reveal that the figures are not strictly comparable, because the capital raised by the companies includes a large nominal increment due to the conversion of stock from a higher to a lower rate of dividend; while in the case of undertakings owned by local authorities the total amount of the loans borrowed includes the amount paid, upon transfer, for the goodwill of the undertaking. In principle, these additions are similar, as in both cases they arise from turning nominal capital into something more nearly approaching its value upon the market. Therefore, in making a comparison of the capital of companies and local authorities, the amount paid for goodwill by the local authorities should be a set-off as against the nominal increment by conversion of the companies.

The details of the nominal increments are scattered as notes throughout the Board of Trade returns; and they can, with time and trouble, be collected and stated. On the other hand, unfortunately, the amounts paid for the undertakings upon transfer are not contained in the returns; and, consequently, the figures for these must be obtained from outside sources, which it is almost impossible to do for the whole of the undertakings. A table is given at the end of this paper showing the total figures abstracted and arranged for the whole of the statutory undertakings in the United Kingdom, giving the nominal increments upon conversion in the case of the companies but without any adjustment for goodwill in the case of the local authorities. This latter figure, however, has been taken out for 16 of the largest undertakings; and it amounts altogether to £137 per million cubic feet of gas sold upon the existing consumption of those undertakings. It is not suggested that this would be an accurate measure of the deduction to be allowed over the whole; but it gives some idea of the effect upon the capital of the payment for goodwill at the time of transfer.

The table (p. 882) covers a period from 1886 to 1906, which is the last available return, and is subdivided into five-yearly periods in order, as far as possible, to eliminate small annual fluctuations. It will be observed that in the case of the companies the net capital outlay has steadily fallen from £675 until it now stands at £610 per million cubic feet sold; while in the case of the local authorities, the total amount of money borrowed per million cubic feet fell until 1897, when it stood at £616. It has since risen to £639. But if allowance were made for the increase at the time of transfer, the figure would be lower than the net capital outlay of the companies. Although the net amount of capital employed by the companies has steadily fallen, the rate of reduction during the last ten years has been much slower than previously; while in the case of the local authorities, the amount of money borrowed per million cubic feet has actually risen. This is no doubt due to the heavy expenditure now required on matters outside the works proper.

The capital cost involved by increase in the output of gas has also been shown; and this makes still clearer the effect of modern conditions. After 1891, the capital cost per million of increase rose, in the case of the companies, to £648, but has since fallen to £603; while in the case of the local authorities, the cost has risen steadily from £337 in 1892 to £723. The difference probably arises from the companies placing a larger proportion of the expenditure upon slot supplies to revenue, which is a wise precaution, as in their case money carried to capital is permanent; whereas in the case of the local authorities it will be paid off within a given period.

The main difference between the capital accounts of companies and local authorities is furnished by the operation of the sinking fund, which has reduced the loans out-



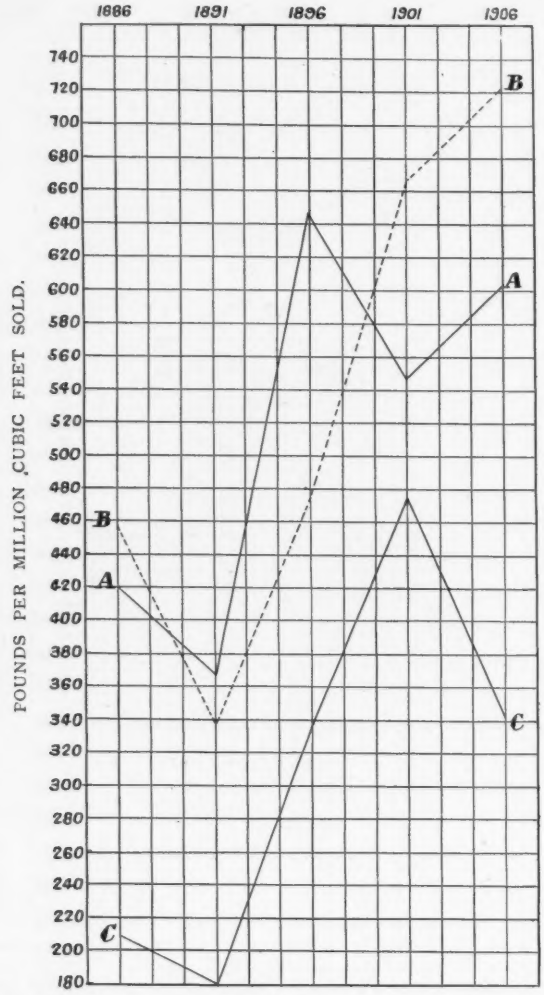
A. Companies—Share and loan capital paid up and issued.
B. ,, ,, ,, ,, less nominal increment by conversion.
C. Local Authorities—Total amount of money borrowed.
D. ,, ,, ,, ,, less loans repaid, &c.

Diagram A.—Total Capital per Million Cubic Feet Sold.

standing from £612 per million in 1887 to £457 per million in 1907; so that, in spite of the increased expenditure upon capital account now necessary, the outstanding loan per million cubic feet of gas sold is steadily falling. There is now a difference of £153 per million in the net capital of the local authorities and the companies, and a difference of £309 per million between the outstanding loans of the local authorities and the capital of the companies upon which dividend or interest has to be paid. As time goes on, this difference is bound to increase. There is no prospect of a decrease in the rate of capital expenditure for a given output; and the question presents itself as to whether the time has not arrived when an effort should be made to enable the companies to reduce their capital.

This is not without precedent. In the year 1903, the Gaslight and Coke Company were restricted from paying any increase of dividend above the standard unless they first placed a definite sum to a fund for the redemption of capital—the sum varying according to the amount of the increased dividend. The fund was to be formed from money which the Company might otherwise have divided as increased dividend; and the total amount of capital to be redeemed was limited to £1,000,000. It is true that this sum is small compared with the total capital of the Gaslight and Coke Company; but if the principle is sound, it is purely a matter of detail as to what proportion of capital should be subject to redemption. Original capital ought in any case to be exempt from the operations of such a fund; so that under no possible circumstances could the whole of the capital be repaid.

If the annual repayments are to be sufficient to effect a material reduction in the capital, it is hardly practicable for the redemption fund to be accumulated from profits which might otherwise have been divided, unless the increment under the sliding-scale is considerably increased. But there would seem to be no advantage in this as against definitely stating the increment payable in dividend and the amount to be placed to the redemption fund—keeping them entirely separate. That is to say, for every penny reduction in the price of gas below the standard price a certain percentage upon the capital would be placed to a redemption fund before the increased dividend due upon the decrease of price was payable. These payments should be compulsory in respect of dividend above the standard rate; but there seems no reason why companies should not have the option of placing to a redemption fund any proportion of the money which



A. Companies—Share and loan capital paid up and issued, less nominal increment by conversion.

B. Local Authorities—Money borrowed.

C. ,, ,, ,, less loans repaid, &c.

Diagram B.—Increase in Capital per Million of Increase in Gas Sold.

they might otherwise have divided, even although the full standard dividend was not being paid.

It might possibly be a still better arrangement that a definite percentage upon the capital should be paid into a fund before any increase of dividend was made under the sliding-scale—the exact amount being calculated according to the rate at which it was thought desirable to make the redemption. After this amount had been found, the sliding-scale and increased dividend would work in the ordinary way without further compulsory payments for the extinction of capital. In the case of maximum companies, the compulsory payments would have to be made out of moneys in excess of the maximum dividends; but these payments should be precedent to any sums being placed to reserve. The option as to using any proportion of divisible profits for repayment of capital should apply to maximum companies as well as to sliding-scale companies.

The sums set apart for redemption should be applied as soon as available, in order to extinguish the interest. The capital would have to be bought upon the open market, and the amount purchased then cancelled. But if shares were not available, as might very well be the case with smaller companies, the money set apart for redemption might be used for purchasing new shares when an increase of capital was necessary. As the payments might be interrupted, a sinking fund in which the payments must be made regularly would not be applicable unless the sinking fund instalments were made precedent to the payment of any dividend—a proposal which most companies would probably consider far too drastic for adoption.

It is not possible to settle a detailed scheme which could be applied without modification to every undertaking in the United Kingdom. The adoption of any scheme might possibly involve alterations to the existing standard price and sliding-scale, and would have to be suited to the conditions of the particular company. It may be objected that the proposal is bound to increase the price of gas, or reduce the dividend; and this might occasionally happen in the early years. But if the capital were paid off by equal annual instalments, the total payment for instalments, with interest on the capital at (say) 5 per cent., would be a constantly reducing amount; and after twenty years the interest on the balance of the capital, and the annual repayments, would come to less than the bare interest on the original capital outlay—the total payment for instalment and dividend decreasing annually until the whole of the capital had been redeemed. A low capital account is so obvious an advantage in the struggle with our competitors—a struggle which is likely to be even keener in the future than in the past—that some present sacrifice would assuredly be justified in order to obtain it.

Discussion on Mr. Lees' and Mr. Valon's Papers.

The PRESIDENT said the name of Mr. Valon was an honoured one in the Institution; and he was glad to find that Mr. Arthur Valon had kept up the reputation of the family.

Companies.

Year Ended December.	Authorized Undertakings. Number.	Inc.	Sale of Gas. Million Cubic Feet.	Share Capital Paid Up (including Premium) and Loan Capital Issued. Gross Amount.	Per Million.	Nominal Increment by Conversion.	Per Million.	Net Amount.	Per Million.	Increase in Sale of Gas. Million Cubic Feet.	Gross Amount of Capital.	Per Million of Increase	Nominal Increment.	Per Million of Increase.	Net Amount of Capital.	Per Million of Increase.
				£	£	£	£	£	£	£	£	£	£	£	£	£
1886	377	..	54,310	36,639,856	675	*nil*	*nil*	36,639,856	675	8,825*	3,704,921	420	*nil*	*nil*	3,704,921	420
1891	422	45	65,338	41,144,281	630	451,130	7	40,693,151	623	11,028	4,504,425	408	451,130	41	4,053,295	367
1896	433	11	73,751	49,619,035	673	3,471,921	47	46,147,114	626	8,413	8,474,754	1,007	3,020,791	359	5,453,963	648
1901	454	21	89,685	73,977,378	825	19,125,707	213	54,851,671	612	15,934	24,358,343	1,529	15,653,786	982	8,704,557	547
1906	491	37	105,219	86,476,293	822	22,265,347	212	64,210,946	610	15,534	12,498,915	805	3,139,640	202	9,359,275	603

Local Authorities.

Year Ended March.	Authorized Undertakings Number.	Inc.	Sale of Gas. Million Cubic Feet.	Total Amount of Money Borrowed.	Per Million.	Total Amount of Loans Repaid, Annuities Redeemed, and Amounts Placed to Sinking Fund.	Per Million.	Total Amount of Money Borrowed, less Sums Repaid.	Per Million.	Increase in Sale of Gas. Million Cubic Feet.	Total Amount of Money Borrowed.	Per Million of Increase.	Loans Repaid, &c.	Per Million of Increase.	Money Borrowed, less Loans Repaid, &c.	Per Million of Increase.
				£	£	£	£	£	£	£	£	£	£	£	£	£
1887	162	..	26,371	19,723,046	748	3,583,355	136	16,139,691	612	5,242*	2,396,863	457	1,300,350	248	1,096,513	209
1892	182	20	34,532	22,476,180	651	4,866,325	141	17,609,855	510	8,161	2,753,134	337	1,282,970	157	1,470,164	180
1897	208	26	43,133	26,561,689	616	6,057,445	140	20,504,244	476	8,601	4,085,509	475	1,191,120	138	2,894,389	337
1902	251	43	54,373	34,045,442	626	8,215,717	151	25,829,725	475	11,240	7,483,753	666	2,158,272	192	5,325,481	474
1907	272	21	62,727	40,089,167	639	11,403,670	182	28,685,497	457	8,354	6,043,725	723	3,187,953	381	2,855,772	342

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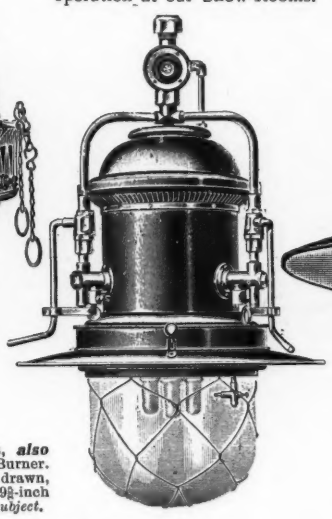

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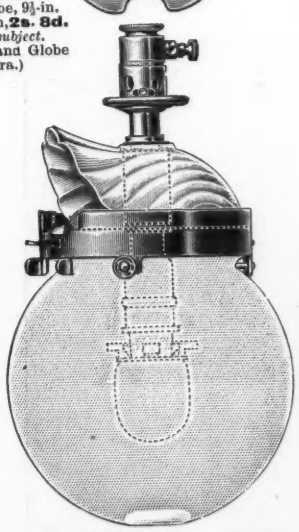

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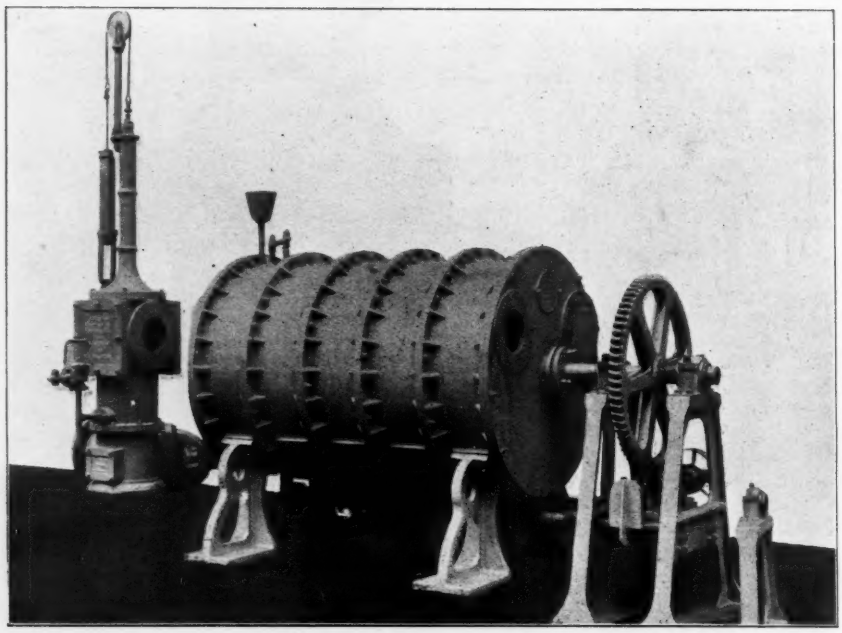

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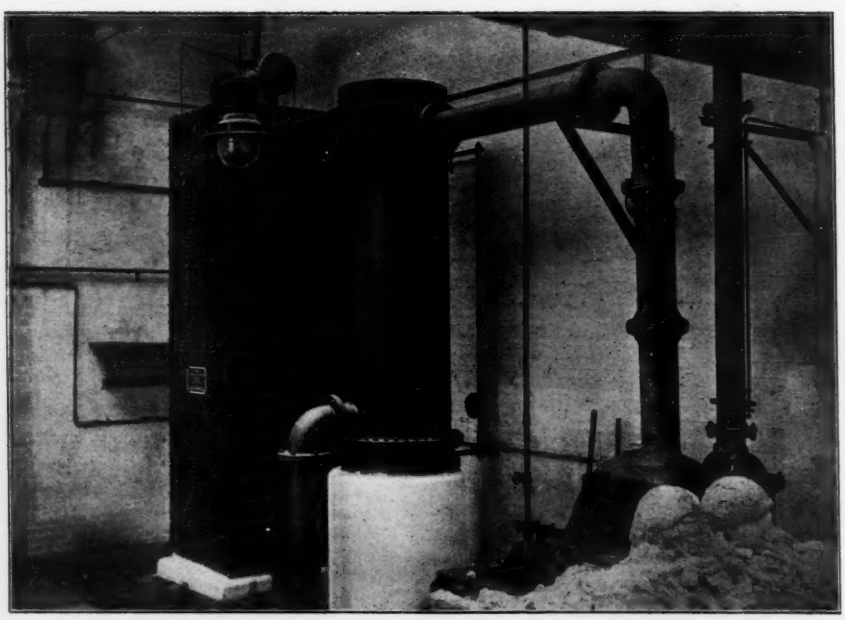

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Mr. Edward Allen (Liverpool) said, unfortunately, he had not heard Mr. Valon's paper read; but he had perused it beforehand, and fully appreciated its value. He had taken more personal interest in the paper by Mr. Lees; and he was sure that the Institution greatly benefited by having contributions of this nature. While, no doubt, many of the problems which confronted them had to be dealt with from an engineering or chemical point of view, after all the question was: Did it pay? And it was only by having careful and accurate accounts kept of the working of processes, plant, and machines, that they could settle this question. Therefore, after all, the working costs were of importance to every engineer and gas manager. It had been said that it was good for every man to have a wholesome measure of discontent. Nothing gave one this feeling so much as for a man to get hold of working costs of some other undertaking which showed his own position to be unsatisfactory. The beneficial result was that he at once endeavoured to remedy any defects he could discover; and he was sure Mr. Lees would be quite satisfied if this was the effect of his paper. The spirit of emulation was an excellent one. This matter was even of more importance in the case of engineers having charge of more than one works. He did not mean to say they could expect to see costs exactly the same in each works, because there were circumstances and conditions which were sure to vary; but when they found considerable differences between results of certain works, they wanted to know the reason why. They could not be at each works every day; but when they looked up the periodical returns, and found certain differences, they went to the man in charge and asked for an explanation. And very often great advantage to the undertaking resulted.

Mr. D. Irving (Bristol) thought he should best serve the interests of the members if he wrote the few remarks he had to make, instead of detaining the meeting. They were indebted to both gentlemen for the very laborious and able contributions put before them. Personally, he should like to thank his old friend Mr. Lees for his kindly reference to his own contribution; and he was delighted to hear that nearly all the conclusions which were arrived at in 1905 were fully confirmed by the past four years' working. As Mr. Lees had said, it was very useful to have these comparisons brought up to date. The only thing that he would venture to express any regret about was that these valuable analyses, which had afforded them so much assistance and guidance for years past, did not include the works of their esteemed friend Mr. Allan. For some reason, they had dropped out; but, after the warm expression of approval of the analyses published by his colleagues and friends, they might hope in the future to have the advantage and benefit of statistics from their great Northern port.

Mr. David Vass (Airdrie) said he would deal more particularly with Mr. Valon's paper. The *crux* of the whole paper lay in the question it formulated, whether the time had not arrived when an effort should be made to enable companies to reduce their capital. This took quite the opposite view to that expressed in the closing paragraph of Mr. Lees' paper. It took the view almost that they were, as it were, a dying industry, and must keep down their capital, just as if they were like an undertaking, such as a coal mine, which was eating up the property in which the capital was invested. This seemed to be the trend of the proposal made. But, how would the suggested remedy affect the parties concerned. It seemed to him it would be against them all. First, it would be against the shareholders, because the sum proposed to be set aside as a sinking or redemption fund would be taken out of that which would be applicable for dividend. He was not forgetting that it would also be applicable in a sense for reducing the gas-rate in the following year in the case of a sliding-scale company, because if they gave increased dividends, they must reduce the price. So that the two parties the most interested—the shareholders and the gas consumers—would be immediate sufferers from the introduction of a redemption fund. The third point was the business of the undertaking. It was said that if they could reduce the selling price of gas to-day, it would increase their business. If they could make their business popular to-day, twenty years hence could look after itself; and if they could increase their business year by year, they would have such a fund of capital invested as would amply repay anything which might be called for in the way of sacrifice. He suggested that no one would be benefited by this at all. The coming generation would be handicapped. They would only be relieved to the extent of a percentage from the sum set aside for the redemption fund; whereas the working cost would be materially decreased as the quantity was increased, and this would more than compensate for anything in the shape of the sum set aside for redemption of capital.

Mr. John Carter (Lincoln) agreed with the previous speakers as to the value of the communications; and said that anyone who gave them a paper useful to discuss, and particularly useful to think over afterwards, was entitled to recognition. He had followed Mr. Lees' contribution very closely; but he was not quite sure that, if they could get the full, amplified, and complete statement of comparison as to the actual condition of affairs as between gas companies and municipal authorities, certain of his friends would be exactly satisfied with the result. He did not think the claim that municipalities might well set up to sell gas on the average cheaper than companies was one which could for a single moment be successfully contested. Mr. Lees mentioned two or three factors, which no doubt affected municipalities more than gas companies. For instance, he pointed to the fact that they made larger surplus profits; but he forgot to mention another very heavy charge which municipalities had to carry—a charge which Mr. Valon particularly dealt with, and which they knew very well as the sinking fund. This had to be set aside before arriving at the surplus profits. He turned with great interest to Mr. Valon's paper; and he thought it was about time that any spirit of rivalry or controversy between gas companies and gas undertakings conducted by municipalities should come to an end. It was high time that each of them recognized that there was a great amount of devotion of skill and inteiligence displayed in conducting gas companies' undertakings. They rejoiced in their success. But, without being charged with immodesty, the same claim might be fairly made for the large and the medium-sized, and even small, gas undertakings which were the property of the various local authorities. He was often tempted to think that, in the discussion of gas matters, local authorities did not get that fair and impartial treatment from men of authority that they were entitled to. With regard to the capital generally invested in the gas industry, judging by the market prices neither gas companies nor corporations had the slightest cause for misgiving or doubt as to its standing in the country or its value as a personal investment. The importance of the part played by municipalities in the gas industry generally was very marked. When they remembered that, outside the Metropolitan area, approximately 50 per cent. of the capital embarked in the manufacture and supply of gas was raised by the various local authorities, this was a very sensible proportion, and showed how largely the principle of municipalization had been adopted with regard to gas matters. Those who were responsible for this approximate 50 per cent. of Provincial capital had too often in recent years been subjected to the charge that they were guilty of wild, reckless, and even riotous extravagance in the expenditure of public money, as particularly applied to their trading concerns. The main purpose for which he rose was to point out what a significant suggestion was contained in the paper Mr. Valon had read—viz., that, after all the financial criticisms which had been offered by men who, he supposed, in some quarters were regarded as men of authority, and capable of speaking on matters they professed to enlighten the public upon, after all they had heard from adverse critics of this class, principally City men, they had listened to-day to a suggestion that if the capital affairs of gas companies in this country were to be put into as sound a position as were those of municipalities, then some drastic change was immediately necessary.

Mr. J. P. Leather (Burnley) said that, speaking some few years ago at an Institution meeting, on the question which Mr. Valon had just brought up he suggested, though he was not connected with gas companies, that it would really be advisable for them to have some such thing as a redemption fund—not necessarily because they thought, as Mr. Vass had suggested, that the gas industry was a dying one, but because it was the general principle adopted in most industrial undertakings. It was quite true that gas was in a rather exceptional position, because all the companies which were worth talking about operating at the present day, were statutory undertakings; but, at the same time, in ordinary industrial undertakings it was usual to put something aside, even though the business might be on an exceedingly good foundation. At that time, he referred to an undertaking in which he had a small amount of interest (and he wished it were larger), which paid a good dividend, in the same way as a gas undertaking, but which put aside a very considerable

proportion of the profits towards redemption of capital. The way in which this was done in the case he referred to, and in common with many industrial undertakings familiar to members, was by raising a considerable portion of the capital by mortgage—only part being share capital. To an extent this was true of some gas companies, who had a certain amount of borrowed capital, though usually it was mostly share capital. If a portion were borrowed, the redemption Mr. Valon spoke of could take place more readily, not with the idea of paying off the whole of the capital, but to prevent it growing quite as fast as the capacity of the undertakings for making gas was growing. It was only an ordinary, sound, business procedure that the capital should be kept fairly low, because, eventually, it tended towards a reduced cost; and, although they might not at present see any reason to doubt that the gas industry would be for very many years to come in a sound position, no one could tell what would happen in the next fifty years—especially if they looked back at the last half-century. They might have to meet much more severe competition in the next fifty years; and therefore Mr. Valon's suggestion to take some steps to prevent capital increasing so fast as appeared usually the case seemed to be a wise one.

Mr. D. T. Livesey (East Grinstead), after thanking Mr. Lees for the useful figures he had given them, said he rose chiefly with regard to Mr. Valon's paper, because it seemed to him that the suggestion made was absurd. To his mind, there was no reason why any gas manager should not be able to keep the capital down by using the facilities they all had, in extending and improving their works, of raising some portion of the cost from the revenue account. He wanted to ask Mr. Valon who was to find the money which was to reduce the capital? Were they to tax the present consumers for the benefit of the future, or rob the present shareholders for the benefit of future shareholders? It seemed to him they must do one of these two. To find money at present to reduce capital, meant taking it either from the shareholders or the consumers. The gas business was in such a prosperous condition—the market value of the shares was so good—that there seemed to be no necessity whatever for the suggestion now made. They all knew that electricians, when they wanted to renew a piece of apparatus, simply said that extensions were needful, and therefore they wanted more capital. But this would find them out in due time. They themselves could do just the opposite. They could carry out their extensions and improve their works largely from revenue; and, if this were done judiciously, and not too quickly, it would prove far better than any attempt to reduce capital, when they could pay a reasonable interest on it, and also treat consumers with due consideration.

Mr. A. Yuill (Dundee) said he should not have trespassed on the time of the meeting simply to support his friend Mr. Lees; but he wished to explain that the statements Mr. Vass had made were not consistent with the facts. He did not wish it to be assumed that the gas industry was a dying one. He could not speak for the position of matters south of the Tweed; but he could speak for the other side of the Border, and more particularly for the town he represented. In Dundee, they had every reason to be satisfied with the progress the gas industry had made, despite the great opposition some of them experienced from their friendly rival, electricity. Both had gone on prospering. There was a field for both; and no doubt they would continue to prosper. But he wished to emphasize, as a point on which he had practical experience, that mentioned in Mr. Valon's paper—capital expenditure. Anyone who took an interest in the commercial management of a works soon realized that if he overloaded his ship greater difficulties were experienced in navigating it; and, if they overloaded their works with capital unnecessarily, they increased the fixed charges, and were not in a position to sell gas economically. This had to be considered at the present time when they had canvassers going not hand in hand, one for gas and the other for electricity. The consumers naturally listened to both; but the influence of the "almighty dollar" dominated their actions. To show how corporations benefited by the reduction of capital expenditure on gas-works, he might say that when his undertaking was acquired by the Corporation about forty years ago, the capital stood in relation to the make at over £1200 per million cubic feet, which was rather a high figure, and was a great handicap in the proper working of the concern. He was pleased to say that to-day it stood at a little over £430 per million, which placed them in such a position that they were able to compete in a friendly way with their competitors.

Mr. J. H. Brearley (Longwood) said there was one point which he thought was not realized by previous speakers, and that was that the repayment of capital by a sinking fund or otherwise by a gas company would be exceedingly difficult to carry out in practice. If an Act such as Mr. Valon indicated were passed, it would weigh most heavily on the very undertakings which could least afford to set aside a sum for the repayment of capital in addition to meeting their ordinary charges. The companies with the highest capital were those which were most keenly hit by competition. How, then, were they going to meet this competition if, in addition to other things, they had also to set aside a certain sum for the repayment of capital, such as was indicated? Of course, the answer was that possibly those companies would fall on evil days by not reducing their capital. But his conviction was that this day would be hastened if they had to set aside such a sum, instead of reducing the price of gas. He congratulated both gentlemen on the papers they had read, and particularly Mr. Lees for pointing out one matter—namely, the danger of following too hypnotically the idea of getting the highest amount of gas from a ton of coal, and selecting coal, altogether regardless of its economical value, with a view to getting a large yield. They had had high makes bandied about pretty freely that morning; but he hoped this would not tempt any man to forget for a single moment the relative value of small coal as against (say) coal from the best seams. Some of them prided themselves on the fact that they had not a great yield of gas per ton. They might get higher yields possibly by improved methods of carbonization; but he was quite sure that, with the coals they used, they would never attain anything like the high yields put forward in some of the papers. Reverting for a moment to the question of gas companies repaying capital, when he referred to this some eleven years ago, in his maiden paper read before the Manchester District Institution, one of their old members got on his track, and said that a gas company would become a financial bubble if some such means of repayment was evolved. But Mr. Valon had put forward a suggestion which was worthy of consideration. If they got larger powers for renewal and reserve funds, the case might be amply met, rather than by definitely repaying a certain amount of capital. They wanted some go-between, between piling up capital and trying to wipe it out altogether; and the go-between which commended itself to him was that of having greater power to set aside reserves.

Mr. Lees said he appreciated some of the kind remarks which had been made; but Mr. Carter seemed to be delivering a speech, not so much in reply to what appeared in his paper, as to what he had read or heard in the City. He quite appreciated the good feeling that ought to—and he believed did—exist among all those engaged in the gas industry. Some of his most intimate friends were managers of corporation undertakings, while others were in company concerns; and he would not knowingly say a word which would appear to reflect upon their work. He did not think Mr. Carter really suggested that he did. He need not discuss the question as to how far the same results would be obtained if the investigation was carried farther, though he had his own views on this matter, and he thought probably he was about right. They could not, of course, eliminate any particular item. For instance, they could not eliminate sinking-fund charges. The consumer had to pay this item in the case of a corporation; so that it became part of the capital charge. The one point he wanted to make clear was that it was a tax on the gas consumer under a corporation to have to pay this additional charge for gas, over what he would pay if a company owned the undertaking; and his investigation went to prove clearly that he did pay more than he ought to do. He thought Parliament was coming to the same conclusion, and was doing what it could to rectify the matter. This was about the only matter of controversy in the paper. There was one other point which he might have taken up, though it had not been mentioned. It had been suggested to him that the reason why the rates appearing in corporation accounts were higher than in companies' accounts was that corporations frequently would not appeal against the assessment of their undertakings. He was not in a position to say how far this was correct; but it was not quite fair to the consumer to assume that, because the corporation collected the rates, the undertakings should not be properly assessed. The rates were paid outside a borough in many cases, as well as inside; and the consumers of the borough

were being over-rated if the gas undertaking was over-assessed. These were points which did not seriously affect them, but affected the consumers of a corporation undertaking; and the corporation would be well advised in such cases to overhaul their assessments.

Mr. VALON said the first point made with regard to his paper was by Mr. Vass, who suggested that he (Mr. Valon) looked upon the gas industry as a dying interest. Personally, he should be very sorry if he thought the gas industry was dying; but he did not think so at all, and did not believe anything in his paper ought to lead one to this conclusion. Mr. Vass gave as an instance of a dying interest a coal mine. Of course, to a certain extent, in this sense, they were a dying interest—that was to say that, if the coal was worked out, and when the coal was worked out, he presumed there would be—he would not say no gas companies, but no coal-gas companies. Then Mr. Vass said the shareholders and consumers would both be sufferers if any proposal for the repayment of capital were adopted, because it would be an extra charge on the gas, and this would be either an extra price or a reduced dividend, or both. Of course, if they were going to repay capital, they must obtain the money to do so from the consumer in the first instance; and, as he said in the paper, for a time the consumer might have to pay a somewhat higher price for his gas than would otherwise be the case. What, however, he endeavoured to show was that, in spite of this, it was desirable that they should charge the extra price at present, so that in future they might be able, not only to charge a correspondingly lower price, but a price even lower in proportion. If they increased the price now by (say) 1d. or 2d., in twenty or thirty years they might be able to reduce it by 3d. or 4d. Again, he did not think it was at all desirable that there should be a very considerable difference between the capital charges in the case of corporations and companies. The consumer supplied by a corporation had to find the charge for the sinking fund; and if consumers under companies had also to find this charge, they would only be doing the same thing. There was £157 per million difference between the amount of capital outstanding now, and a difference of over £300 in the capital upon which interest or dividends had to be paid. If this was going on increasing, he thought gas companies would find that the argument would be a very potent one in favour of the further transfer of undertakings from companies to corporations. Mr. Livesey suggested that the capital could be kept down by undertaking extensions out of revenue. Of course, if they did this, they would be doing exactly what he suggested, except that they would be doing it irregularly—he would not say illegally—instead of doing it in a regular and proper fashion. Mr. Livesey might find, when he had to go to Parliament for further powers, and had been doing a large amount of extension work out of revenue, that the Committee would not look at his operations quite so sympathetically as perhaps he hoped, and probably deserved. As to the charge for repayment being a charge on the present consumer in favour of the future consumer, it ought to be pointed out that the works were being worn out by the present consumer; and therefore the charge for replacing capital ought to be borne by him, and not by the future consumer. Mr. Yuill mentioned that in his case the capital had been reduced from £1200 to £430 per million; and, of course, this must have been done out of the pockets of the consumers, but apparently it had been accomplished to the advantage of everybody concerned. Mr. Brearley had suggested that it was just in those cases where there was heavy capital that it was most desirable that capital should be reduced, and at the same time it would be most difficult to do it, because they did not want to do anything to increase the price of gas. But Mr. Yuill's example perhaps would counterbalance this. If in the case of a company with very heavy capital it was found impossible to reduce it quite as fast as was desirable, at all events some arrangement could be made so that eventually it would be reduced to something in proportion to other undertakings of the kingdom. Mr. Brearley also suggested that it could be done by allowing the companies to have a much larger reserve, or in some other way. But this came to exactly the same thing; it was only a different way of doing it. It did not matter how it was done, so long as the capital was kept within bounds. He might point out that to provide a larger reserve would be just as great a burden on companies with a heavy capital and high price as the suggestion he had already made.

This closed the discussions.

THE BENEVOLENT FUND.

The Annual Meeting of Donors and Subscribers to the Benevolent Fund was held on Wednesday morning—the chair being taken by the PRESIDENT.

The minutes of the previous meeting having been read and confirmed, the report of the Committee of Management was taken as read.

The PRESIDENT, in moving its adoption, said the Committee inquired very carefully into each case before voting money; and though they had been able to make a grant in every case of real need, there were instances in which they would have liked to give more. In future they might be obliged to refuse aid in some cases unless the fund was well maintained and new subscriptions came in. The fund had received a great impetus from the action of the Midland Association through Mr. Meiklejohn. Other Associations had followed the good example; and a great deal more interest had been stirred up in the important work of helping unfortunate members and their families. He therefore hoped that, not only would the present subscriptions be kept up, but that others who had hitherto held aloof would see it was their duty to assist the fund.

The motion was duly seconded and carried unanimously.

The PRESIDENT announced that, as the result of the ballot, Messrs. Thomas Bower (West Hartlepool) and Hubert Pooley (Stafford) were elected members of the Committee.

Alteration of Rules.

The PRESIDENT then moved the adoption of a set of amended rules which had been printed and circulated, subject to a further alteration in Rule 12 which had been made that morning by the Committee, the effect of which was to place the Honorary Secretaries of the Affiliated Associations on the Committee, instead of the District Members of Council, as originally proposed.

Mr. J. T. JOLLIFFE (Ipswich) seconded the motion.

A short discussion ensued on certain matters of detail; but after some further explanation from the President, the amended rules were unanimously adopted, and the proceedings terminated.

STANDARDIZATION OF PIPE-THREADS.

REPORT by Mr. JAMES W. HELPS.

(See p. 819.)

I beg to report that, accompanied by Mr. Leslie Robertson, the Secretary of the Engineering Standards Committee, and Mr. Krause, a member of the same body (Mr. Thos. Glover, the President, being unfortunately unable to be present owing to pressure of Institution and other business), I attended the second session of the International Commission appointed to deal with the "Unification of Pipe Threads," which was held in Paris on June 8, 9, and 10.

It will be remembered that at the first session, held in the same city in June, 1908, certain decisions were arrived at, as set forth in your Council's report for the past year. These decisions were brought to the notice of the Engineering Standards Committee, who, as they did not approve of them, drew up a memorandum of their objections, which was submitted to, and accepted by, your Council, and accordingly included in their report. The principal points of difference were as under:

(1) The angle of the thread, which was fixed by the Commission at 60°, as against the 55° of the Engineering Standards Committee.
(2) The method of fixing the gauge diameter of the pipe.
(3) The shape of the thread with regard to the amount of truncation.
(4) The pitches of the threads of certain sizes.

At the commencement of the meeting, it was pointed out that, inasmuch as several important and interested countries were not represented, it would not be advisable to take any definite vote by countries. It was, therefore, agreed to confine deliberations to a consideration of the opinions of those present, with the object of ascertaining the extent to which agreement would be possible with a view to a future conference.

Angle of Thread.—With regard to the angle of the thread, the general opinion was in favour of 60°; but your repre-

sentatives (and those of Switzerland) strongly upheld the advantages of the Whitworth angle of 55°.

Gauge Diameter.—The gauge diameter was next considered; and, after a lengthy discussion, the definition suggested by your representatives met with the most approval. It was to the effect that the gauge diameter should be taken as the diameter of the pipe at that point of the conical thread (1 in 32) at which the parallel coupler or socket made a hand-tight joint, or, in other words, the inside diameter of the coupler itself.

Shape of Thread.—With regard to the shape of the thread, the suggestion that truncation at the root and crest should be so effected as to make the height 8-10ths of the pitch, was most generally approved.

Pitch.—The most important matter—viz., the pitches of the threads—was then discussed. There was very little difficulty in agreeing as to those pitches for pipes under 2 inches in diameter, as most countries seemed fairly in accord, and but slight concessions were necessary to arrive at a general agreement. The principal points of difference arose when the consideration of pipes over 2-inch diameter was reached. These were fixed at the conference of 1908 at 7·9 threads per inch, or 3·20 mm. pitch, as against the 11 threads, or 2·30 mm. pitch, in use in Great Britain and most Continental countries. It was pointed out that the coarser thread as used in America was designed to meet conditions which arise under the somewhat special circumstances at times met with in American practice; and after some considerable discussion, the finer pitch of 11 threads to the inch met with general acceptance. It will be seen that the gauge diameter and pitches which were provisionally approved as given in the table below very closely follow British and Continental practice.

Pitch.	Outside Diameter.
1·00 mm.	10 mm.
1·40 mm.	11 ,,
	13 ,,
	16·5 ,,
1·80 mm.	21 ,,
	26·5 ,,
	33 ,,
2·30 mm.	42 ,,
	48 ,,
	59·5 ,,
	66 ,,
	70 ,,
	73 ,,
	75·5 ,,
	81·5 ,,
	88·5 ,,
	94 ,,
	101 ,,
	106·5 ,,
	114 ,,

Before the close of the conference, it was arranged that the Société Technique de l'Industrie du Gaz en France should appoint a Sub-Committee of that body charged with the duty of obtaining the opinions of the various countries interested, with a view to laying the information when obtained before a further meeting to which the countries concerned should be formally invited to send representatives.

Your representatives desire to acknowledge the courtesy and hospitality shown them by the President and Council of the Société Technique, and the efforts which the Society is making in the direction of a general agreement on the important subject under discussion.

May I, in conclusion, express the opinion that this Institution is greatly indebted to the Engineering Standards Committee for permitting their representatives to attend the conference, and to Mr. Leslie Robertson and Mr. Krause for the valuable assistance they rendered thereat.

(Signed) J. W. Helps.

Death of Mrs. Forbes Carpenter.—We regret to learn that Mr. R. Forbes Carpenter, the Chief Inspector under the Alkali Works Act, has just sustained a severe bereavement by the death of his wife. This heavy blow has come upon him not long after his recovery from an illness which delayed the preparation of his report, noticed in the last issue of the "Journal" and again to-day.

The Gas Engineering Endowment at Leeds.—At a meeting of the Court of the University of Leeds last Wednesday, Professor Smithells submitted a resolution to amend an ordinance so as to include "Gas Engineering" and "Fuel" among the subjects enumerated therein. In doing so, he said he had been asked whether the gas engineering endowment involved the appointment of another professor; and he might reply that it would not. It simply meant the endowment of the professorship that already existed.

JOINT CONFERENCE OF COMMERCIAL SECTIONS OF THE UNITED KINGDOM.

Last Tuesday afternoon (the opening day of the annual meeting of the Institution of Gas Engineers), there was held, at the Institution of Mechanical Engineers, Storey's Gate, S.W., a joint conference of the Commercial Sections of the United Kingdom, which was called to consider various resolutions. In the notice summoning the conference which was issued by the Hon. Secretary *pro tem.* (Mr. H. Kendrick, of Stretford), the hope was expressed that every member of a Commercial Section would be present; and it was stated that all gas engineers interested in the work would be heartily welcomed. The suggestion was also made that every member should invite his Chairman or a representative of his Committee or Board to be present. The result of this notice was a very satisfactory attendance. At the outset, on the proposition of Mr. Kendrick, Mr. S. Meunier, of Stockport, was voted to the chair. Mr. Thomas Glover, of Norwich, the President of the Institution of Gas Engineers, also occupied a seat on the platform.

There were present about 80, including 48 members of the Lancashire, Yorkshire, Eastern Counties (East and West), Cornish, Southern, South-Western, and North British (West and North-West) sections.

The Question of Reporting the Proceedings.

The Chairman remarked that the first thing to be decided was whether the meeting should be absolutely private, or whether the Press should be admitted.

After a short discussion a resolution throwing open the meeting to the Press was carried unanimously.

Minutes of Sheffield and Leeds Meetings.

The Hon. Secretary said it had been suggested that the minutes of the Sheffield and Leeds meetings should be read, in order to put the conference in full possession of what had already transpired. Four sections were represented on these occasions; but he was happy to say that considerably more than this number were represented that day.

The minutes were then read and confirmed.

A Vote of Thanks.

The Chairman pointed out that the next item on the *agenda* was a vote of thanks for the use of the meeting hall—a vote which was thoroughly well deserved. The conference was a new departure, and a step outside the regular procedure of the Institution meetings. It was exceedingly kind of Mr. W. T. Dunn, the Secretary of the Institution, to take the trouble he had to act upon the suggestion made at the Leeds meeting that the present was a proper time to hold a joint conference. Mr. Dunn had approached the Committee of the Institution of Mechanical Engineers; and they very kindly fell in with the idea. He therefore had much pleasure in proposing a vote of thanks to them.

This was heartily accorded.

Statement by the Chairman.

The Chairman remarked that as this subject of Commercial Sections was rather an old one with them in Lancashire and Yorkshire, and especially in the Manchester district, perhaps he might be allowed to give a short *résumé* of the why and the wherefor of these sections. He did not want to take up too much of their time; but he rather thought that many among the junior branches at any rate did not quite follow what had been done in the past by the older ones. The original inception of the Commercial Sections came about by a meeting of perhaps six, or seven, or eight engineers in Manchester, who had to deal with a number of little questions which rather bothered them; and they decided that it would not be at all a bad idea if they interchanged information between one and the other. From this seven or eight, the number increased perhaps to about twenty. Then the aid of the name of the Manchester District Institution was invoked, and granted. They had gone on from this until they had reached the stage at present occupied; but he ventured to assert that they had only just touched the fringe of what the Commercial Sections could be made to effect. Perhaps he might be excused if he gave them a short outline of the reports of the Lancashire Commercial Section—which also included Yorkshire, although they had taken up questions which Lancashire had not. He had in his hand the reports since 1905; and he would venture to trespass on their time while he gave them some idea of the contents. These reports spoke for themselves as to the work which had been done originally. The section was started for the purpose of preventing cutting between one another in the matter of residuals. From this it got to interchange of information with regard to contract prices for coal, tar, sulphate of ammonia, and other things—including sulphuric acid, and all the rest of it. Now it had grown to many other interesting features. From the report for 1905, he quoted the following:

During the past year, in addition to the question of coke, the various contracts appertaining to gas manufacture and distribution have been considered from time to time, including coal, tar, liquor, lime, benzol,

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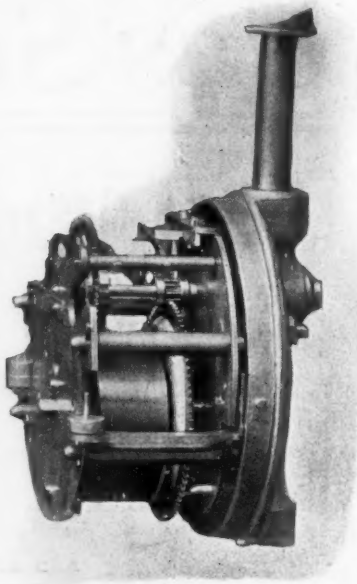

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oil, tubes and fittings, &c. . . . The tabulation of labour queries, which occupied the attention of your Committee during the greater part of last year, was completed, and a copy issued to each of the members who supplied the necessary information. The tabulation is a valuable standard of reference for all classes of labour in gas-works, but will require to be corrected from time to time as alterations take place in the respective works.

He might tell them that in Lancashire and Yorkshire they had a complete set of tabulations, showing the wages paid for every kind and every different class of work which could be found; and when he said that it took them nearly two years to compile this, they would easily understand the difficulty of the task. But they possessed it now; and they kept it up to date. The report continued:

Reference was made in the last annual report to Mr. Pye's "Notes on Rating;" and during the present year copies have been printed and circulated to the members of both the Lancashire and Yorkshire Sections. A short paper was read by the Secretary on the "Maintenance of Incandescent Burners at Heywood," in which he claimed that it was to the interest of gas authorities to take up this question. . . . The important question of "Gas Producers for Power Purposes" was introduced by Mr. Braddock, of Radcliffe, a summarized report of which, together with the discussion at the subsequent meetings, has been forwarded to each member of the section. Mr. Isaac Carr, of Widnes, read a short paper on "High *v.* Low Grade Gas, and the Effect of the Gas-Testing Decisions of the Departmental Committee of the Board of Trade on Gas Authorities and Gas Consumers." . . . The question of relative value of candle power and calorific value was also discussed. . . . Mr. Ball introduced the subject of "Various Methods of Increasing Gas Sales;" the most important point advocated being the reduction of price. . . . This subject gave rise to a long and interesting discussion; and statistics were given by several members showing the progress of their respective undertakings by judicious advertising, and the adoption of special conditions for large users of the day-load, cooking-stoves, grillers, &c. The question of "Arrangements with Plumbers" was introduced by the Chairman at another meeting. He referred to the difficulty of corporations dealing with this question as compared with companies, but was of opinion that special terms and facilities should be offered to plumbers in connection with sales of goods and the carrying out of work for gas authorities. The Committee have also taken into consideration the anomalies which exist in reference to railway rates for carriage of coke and other materials, but have not concluded their investigations. The action of the Anti-Vibrator Incandescent Lighting Company, with reference to the infringement of patent and the effect on mill-lighting and other works received the attention of the Committee. The returns for ammoniacal liquor, sulphate of ammonia, and tar have been tabulated and issued to the members. The Committee have under consideration the question of standard rules and regulations for authorized plumbers, and conditions of gas supply.

From the report for 1906, he took the following:—

The question of ordinary gas-works contracts for coke, tar, liquor, &c., has been considered each month. The following subjects have also been introduced, and interesting discussions have ensued: "Free Cookers," introduced by Mr. Andrew; "Differential Rates for Cooking, &c.," by Mr. Ginman; and "Grouping of Accounts for Discounting," by Mr. Potts. The question of suction gas, naphthalene, and the periods fixed by the Local Government Board for the repayment of loans, have also been considered; and much valuable information was elicited by the discussion of these subjects. The members have also under further consideration the question of railway rates. The returns for ammoniacal liquor, sulphate of ammonia, and tar have again been tabulated. The Committee are preparing a list of rules and regulations for authorized gas-fitters, and conditions of gas supply, which, it is suggested, might be adopted as a standard. The Committee are also tabulating returns from the members of the section, showing the average price realized for coke per ton during the last three years.

The following extracts were from the report for 1907:—

Weekly statements of coke stocks and prices have been issued to the members, and reports exchanged with the Yorkshire Section. The total stocks are reported at the monthly meetings, when the condition of the market and ruling prices are discussed. . . . The shipping trade has been brisk; but many of the members have experienced difficulty in securing waggons. Returns, showing the average price realized at the various works, and other particulars respecting the sale of coke, have been tabulated and issued. . . . It has been decided to subscribe to the Mansion House Association on Railway and Canal Traffic, the principal objects of which are to advise its members on all matters affecting railway and canal traffic, and also watch legislation in the interest of traders. Members will get the benefit of expert advice in cases of dispute with Railway and Canal Companies.

This meant that the members of both the Lancashire and Yorkshire Sections were entitled to bring forward any question that might affect them in connection with railway rates, siding rates, or any other thing appertaining to this particular branch, and through their Secretary obtain the expert advice of the Mansion House Association and their officers. This was secured at an inclusive fee, which they had thought it advisable to pay. The fee did not amount to much; but the advice was extremely useful. The report continued:—

As to the residual market, tabulations of returns showing particulars of production and prices realized by the various works in the section have been issued to the members, which ought to prove of considerable value for reference. The markets for benzol, pitch, oil, carbon, oxide—new and spent, &c.—have also been dealt with. The labour statistics issued two years ago have been revised; and a supplementary return has been issued giving details of alterations in wages and conditions of labour. Various phases of the labour question have been discussed at several of the meetings. The new Workmen's Compensation Act has evoked considerable discussion during the year, particularly the clauses which affected the gas industry. Details of revised rates and other information have been obtained by the Committee, and circulated among the members. Mr. Pye, of Chester, submitted notes on the subject of "Summer Advertising." He advocated novel and genuine advertising, especially in districts where there is practically no expansion. . . . The question of the adoption of "Old Age Pensions" was introduced by Mr. Andrew, of Oldham. Details of schemes in operation in several towns were submitted; and the discussion on the subject was well sustained. . . . Mr. Carr, of Widnes, introduced the subject of "Gas Consumption per Head of the Population," and gave some most interesting statistics respecting the consumption of gas at Widnes. . . . The following subjects have also been discussed: Tarring of roads, hiring of gas heating apparatus, recent experiences with suction-gas plants, reinstatement of trenches, the use of lead and compo. pipe, sizes of meters and pipes, the use of water-slide pendants, oscillation caused by gas-engines, responsibility for escapes, &c., and many other matters connected with gas management. The necessity for revising the Gas-Works Clauses Act, 1871, has been advocated at several of the meetings . . . Reports have been exchanged with other Commercial Sections. . . . During the year, several of the members, when unable to attend the meetings, have sent written communications to the Secretary, giving experiences and particulars relating to their works and district, bearing on the subject announced for discussion.

He did not think he need go further, because the report of 1908 was practically an enlargement of the same business. But what he did want to point out was that these Commercial Sections were not built up as they were originally—simply for talking over tar, coke, or coal. They were of benefit in many respects outside these matters. Every question which arose in any engineer's experience he brought forward, with great advantage, not only to himself, but to the other members. ("Hear, hear.") The points were set forth and discussed, and the general consensus of opinion tended to show, at any rate, the line of procedure which it was safest to follow. This was what was intended; and it was what he hoped would accrue from interchange of opinions between them, because they had many questions in common. If they could only get this interchange of information with regard to circumstances which applied to every district, then they could form themselves into a body which would be useful, not only to themselves and their departments, but to each individual section.

The special resolutions submitted to the meeting were discussed at length; and the main object of the meeting was endorsed, which will result in placing the Commercial Sections of the United Kingdom in a stronger position, by the exchange of ideas and information throughout the country on all matters of commercial interest. Several items of the *agenda*, including the most debatable, were left over to the delegates and sections for further consideration during the next twelve months.

Appointment of Officers.

As the hour was very late, instead of electing officers and a committee,

Mr. R. G. Shadbolt (Grantham) proposed, Mr. Carter (Lincoln) seconded, and it was agreed, that Mr. Meunier and Mr. Kendrick be asked to act as Convener and Secretary of the Joint Conference for the space of another year.

The proceedings concluded with a vote of thanks to the Chairman, on the proposition of Mr. C. Wood (Bradford), seconded by Mr. E. Allen (Liverpool).

Society of Engineers.—Last Wednesday, on the invitation of Messrs. Ellington and Woodall, M.M.Inst.C.E., the Engineers to the London Hydraulic Power Company, a number of the members of the Society of Engineers visited the Company's new power-station, in course of construction at Grosvenor Road, Westminster, about 300 yards west of Vauxhall Bridge. When completed, the building will be the largest of the Company's pumping-stations, and will replace the existing station in Millbank Street. At the time of the visit the works were not in a sufficiently advanced state for the reception of machinery, and interest centred principally in the ferro-concrete construction (the Hennebique system). The station when completed will comprise engine and boiler houses, accumulator tower, chimney shaft, coal-store, filter-house, workshop, store-room, men's room, and foreman's house, with water-tanks over the boiler-house and filter-house. The settling reservoirs in the rear cover an area of 2550 square yards, with a total capacity of about 2¼ million gallons. The station is designed to supply 200,000 gallons of power water per hour, at a pressure of 800 lbs. per square inch. River water is to be conducted into the settling reservoirs at the rear through two lines of 20-inch pipes, laid at about half-tide level. The reservoirs can be emptied to the river at low tide through 14-inch drains. The water, after settling, is to be pumped from these reservoirs through the condensers into an overhead tank above the filter floor. It is then filtered; and from the filters it will flow into another tank, at a lower level, over the boiler-house, whence it will be conducted to the main engines with a gravity head, and pumped into the power mains. There are at present about 165 miles of hydraulic power mains laid in London, and served by five central stations from two to three miles apart. The supply is over 20 million gallons per week, with about 6000 machines at work.

THE LIVESEY MEMORIAL FUND.

We have received from Mr. Walter T. Dunn the following list of further contributions to the fund:—

1909.		£	s.	d.
June 14	Previously acknowledged	9945	2	1
,, 15	John Aird and Sons, London	52	10	0
,, 17	Bridgwater Gaslight Company	5	5	0
	J. S. Dougall, Boston	1	1	0
	Timothy Duxbury, Oldham	1	1	0
	Eastern Counties Gas Managers' Association	21	0	0
	Charles Hawksley, London	52	10	0
	D. H. Helps, Reading	2	2	0
	William Hill, Stalybridge	1	1	0
	R. Hesketh Jones, London	10	10	0
	Lambton Collieries, Limited, Newcastle-on-Tyne	25	0	0
	Dr. Rudolf Lessing, London	2	2	0
	New Zealand Express Company, New Zealand, per Mr. F. M'Leod (South Metropolitan Gas Company)	3	3	0
	J. Wylie Nisbet, London	5	5	0
	Oriental Gas Company, London	15	15	0
	Oughtibridge Silica Company	5	0	0
	H. J. Randall, Tottenham	0	10	6
	J. W. Randell, Fulham	1	1	0
	J. J. Runton, Hull	1	1	0
	W. J. Smith, Carlisle	2	2	0
	J. H. Troughton, Newmarket	1	1	0
,, 21	W. Chaney, Birmingham	1	1	0
	Total	£10,155	3	7

PERSONAL.

PRESENTATION TO Mr. T. C. FULLER.

We offer our congratulations to a gentleman well known to a large circle in the gas profession—Mr. T. C. Fuller, the Secretary of the Isle of Thanet Gaslight and Coke Company, who, on the 3rd of May last, completed his fortieth year of service. He was appointed as the Clerk to the Ramsgate and Margate undertakings on May 3, 1869, and took an active part in the stirring period of 1874 to 1877, when the Ramsgate Local Board sought to acquire the Ramsgate works by compulsory purchase, but were defeated; terms afterwards being agreed to. Again, in 1880 and 1881, he took part in opposing the promotion of the Westgate and Birchington Gas Company. The district and charges being defined, an agreement was entered into, and the Bill was allowed to pass. In 1898, he was again engaged in Parliament; and though the site then selected was withdrawn, the monetary portion of the Bill was granted. Being well known as a hard worker, it is pleasing to have to record that his long service has met with the appreciation of his Board, to which a resolution placed on the minutes of the Company fully testifies. The Chairman of the Company (Alderman L. Hart, J.P.), in speaking of Mr. Fuller, said: "As Chairman of the Company, I feel I should be more than remiss if I did not move that there be placed upon record the high appreciation we have of Mr. Fuller, our Secretary, and his work. For forty years he has devoted himself to the interests of the Company; and, not only to us, but to our predecessors, he has given the highest possible satisfaction in every way. We know that he has ever had but one object, and that has been to advance to the fullest the interests of the Company; and his whole career has been one of continual and continued prosperity for all concerned with him in his work." A very handsome salver was presented to Mr. Fuller at the close of the Directors' meeting last Friday. It bore the following inscription:—

Presented by the Chairman and Directors of the Isle of Thanet Gas Company to Thomas Christopher Fuller, Secretary of the Company, in recognition of his services—May 3, 1869, to May 3, 1909.

Mr. J. F. Bedford, of the Leeds Corporation Water Department, has been appointed, out of 114 applicants, Water Manager to the Colne Corporation.

Mr. Arthur M. Forshaw, M.Sc., who read at the meeting of the Institution last week the paper on "A Comparison between the Illuminating Efficiencies of Carbon Monoxide and Hydrogen when used in Conjunction with the Incandescent Mantle," has been appointed Chief of the research and chemical staff of Messrs. John Wright and Co., of Birmingham.

Mr. W. Brown, Manager of the Lasswade and Bonnyrigg Gaslight Company, Limited, has been appointed Manager of the Gas Company which has been formed for the supply of gas in the Cardenden district of Fifeshire. The Company is the outcome of the increased activity in the coal output of the county of Fife. Mr. Brown, who is a *protégé* of the late Mr. W. Young, of Peebles, has been eight years at Lasswade. He has been President of the Waverley Association of Gas Managers, and is at present Hon. Secretary of that body. He has also held the office of President of the Scottish Junior Gas Association, Eastern District.

On the evening of Friday, the 11th inst., Provost Torry, as the Chairman of the Stonehaven Gas Company, along with the past Chairman and the Secretary, waited upon Mr. W. M'Lean Ross, the retiring Manager of the Company, and presented him with a gold albert and pendant, and Mrs. Ross with a gold brooch, set with diamonds, rubies, and pearls, as tokens of the appreciation and esteem the Directors and shareholders of the Company have of Mr. Ross. In handing the gifts over, Provost Torry expressed the heartfelt wish of the Directors that Mr. Ross and his family circle might be as prosperous under the Southern Cross as they had been in the old country. Mr. Ross thanked the Directors on behalf of himself and his wife.

Mr. Harold Davies, of Blackburn, has been selected to fill the position of Gas Engineer and Manager to the Brighouse Corporation—an appointment for which applications were invited in our advertisement columns some weeks ago. The successful candidate was educated at the Liverpool College, and subsequently at the Liverpool University College (where he studied scientific subjects, engineering, and laboratory work) and at the College of Chemistry. He also made special researches in organic chemistry as applied to gas-works residuals, under Dr. Pickard, the Consulting Chemist and Gas Examiner to the Blackburn Corporation. He holds thirteen certificates for science and art, including one in the Honours grade in "Gas Manufacture." He has had considerable experience in all branches of constructional work, first at Runcorn, where he was a pupil of Mr. J. R. Frith, and afterwards his assistant, and subsequently at Darwen and Colne, where he was the Assistant Engineer and Manager. In November, 1899, he obtained the position of Chief Assistant Gas Engineer at Blackburn, where he was associated with Mr. S. R. Ogden in the designing and erection of the present works, which are equal to an output of 2¾ million cubic feet daily. It will thus be seen that the Brighouse Corporation have secured the services of a thoroughly well-trained man for their Engineer and Manager; and we trust the choice they have made will every year be more fully justified.

OBITUARY.

JOHN TINDALL.

Another name has been erased from the roll of gas engineers who were in active work in the early part of the second half of last century. There passed away on the 2nd of June, in his 79th year (after a paralytic stroke which he had the previous Saturday), Mr. John Tindall, whose connection with the Walsall Corporation Gas-Works up to 1900 brought him prominently before the gas industry; and he was buried in the old cemetery, close by the old gas-works, on the following Saturday. The funeral was attended by the Chairman of the Gas Committee, who is the Mayor of the town, and other local friends, including his successor at the gas-works, Mr. B. W. Smith, together with some twenty or thirty of the employees at the gas-works. Among the many beautiful wreaths sent, one was by the Midland Association, another by Mr. Charles Meiklejohn, another by Mr. A. C. Scrivener, and others from friends in the industry. Deceased was interred in the same grave as his wife, who had predeceased him about ten years. Mr. Tindall went to Walsall in 1874, and resigned early in 1900, when Mr. Smith took up the position; the final severance with the works taking place on the 18th of June. When Mr. Tindall entered upon his duties, the gas-works were situated in Wolverhampton Street. The demand for gas in the town necessitated the extension, in 1896, of the works now known as the Pleck Station; and ultimately the enlargement of the plant there led to the closing down of the works in Wolverhampton Street. Mr. Tindall was highly respected in the profession; and equally in Walsall was he held in very high esteem right up to the closing days of his long life.

The death of Mr. Tindall removes from our midst one of the five gas engineers who, on the 20th of September, 1877, met at the Windsor Street Gas-Works, Birmingham (with Mr. Charles Hunt in the chair), to consider the desirability of forming a District Association of Gas Managers for the Midland area. The first ordinary meeting was called on Oct. 11, 1877, when Mr. Tindall was elected Honorary Secretary, to which office he was re-elected the following year. He was then appointed Honorary Treasurer to the Association. Having filled this office for five years, he was elected President on Sept. 25, 1884, and until his retirement from the management of the Walsall Gas-Works in 1900, through ill-health, he continued to take an active interest in the work of the Association.

GEORGE FREDERICK DEACON.

We regret to record the sudden death last Thursday of Dr. George Frederick Deacon, whose name is well known to most of our readers in connection with the Liverpool and other schemes of water supply, as well as with the waste-recording meter invented by him.

Deceased was born at Bridgwater on July 26, 1843, and at an early age displayed a taste for science and mathematics which marked him out for the engineering profession. After receiving his early training, he studied engineering science at Glasgow University, where he came in contact with Sir William Thomson (afterwards Lord Kelvin), who was then Scientific Referee to the Atlantic Telegraph Company; and through his recommendation,

Mr. Deacon at the age of twenty-one obtained an appointment with the Company. He subsequently commenced practice in Liverpool as a consulting and mechanical engineer, and made a special study of the estuary of the Mersey. At the age of twenty-eight, he secured the dual position of Borough and Water Engineer of Liverpool. Soon after his appointment, the deficiency in the water supply of the city became a very urgent question. Mr. Deacon determined to ascertain whether an economical use was being made of the supply at command; and he subsequently invented and brought into use the waste-meter to which reference has already been made. A great saving was thus effected; and in 1875 the supply of water, which for ten years had been intermittent, was made constant and sent out under higher pressure than before.

In 1881, Mr. Deacon resigned the position of Borough Engineer, in order that he might devote his energies to the duties of the other office. A better water supply for the city had become a generally recognized necessity. He investigated projects for bringing water from Westmorland and Wales; and about the year 1876 he projected the great Vyrnwy scheme. The project had been approved by Mr. J. F. Bateman and Mr. Thomas Hawksley, who were then regarded as the chief British hydraulic engineers. The Water Committee of the Corporation engaged the latter, together with Mr. Deacon, to take charge of the scheme; and they were associated from 1879 until 1885. They agreed that the dam of Lake Vyrnwy should be constructed of masonry; but they were not agreed as to the mode of its construction. This and other points of difference led to Mr. Hawksley's resignation in 1885. Later on the whole question was referred to several eminent engineers, who reported entirely in favour of the method employed by Mr. Deacon, and stated with respect to the dam generally that "nothing short of an earthquake could possibly disturb it." From that date to its completion, Mr. Deacon had entire responsibility of the work. The most serious and difficult part of the undertaking proved to be the aqueduct tunnel under the River Mersey.

This was driven through gravel and sand at a great depth, under free pressure of water from the river above. It was abandoned in turn by two contractors; and in this way, though only 182 feet were completed, a great deal of time was lost. Mr. Deacon thereupon assumed the responsibility of the contractor; and he finished the remaining 620 feet in a few months. As Engineer-in-Chief, Mr. Deacon completed the first instalment of the Vyrnwy scheme in 1882; but since then a second pipe-line has been laid to the city. On the completion of the scheme, Mr. Deacon removed to London, where he practised as a Consulting Engineer. He projected the new water scheme for the Birkenhead Corporation; and up to Monday last week he was constantly in communication with officials of the Corporation, discussing details. He was full of affairs, and had several large projects on hand besides the Birkenhead scheme, for which he was the Consulting Engineer; and his death will be a great loss.

Besides his waste-meter, Mr. Deacon invented apparatus for smoke prevention, mechanical stoking, and grain drying, other differentiating meters, reducing-valves, and heat-engines, for all of which he obtained patents. Among other medals received by him were the Telford, Watt, and Stephenson Medals of the Institution of Civil Engineers, to which body he was admitted as an associate in 1872; and was transferred to the membership list in 1874. He was author of many scientific and engineering papers, including the article on "Water Supply" in the supplement to the ninth edition of the "Encyclopædia Britannica." He was a member of the Institution of Mechanical Engineers, of the Iron and Steel Institute, and other scientific societies, and had been President of the Association of Municipal and County Engineers. He was an LL.D. of Glasgow.

We regret to learn that Mr. D. Hunter Anderson, the Engineer and Local Manager of the Bastia (Corsica) Gas-Works, has sustained a great bereavement by the death of his wife, which occurred on the 1st inst. at Bastia, in her 53rd year.

We much regret to have to record the death, under very tragic circumstances, of Mr. Alfred Richards, of No. 18 Finsbury Circus, E.C. It appears that for the last few weeks, in consequence of unsatisfactory health, he had been travelling in Wales and Scotland, whence he returned to town on Tuesday evening last. On Thursday, without giving the slightest indication that the nerve trouble was deep-seated, he took his own life by shooting. It is, of course, well known that Mr. Richards, who was a keen sportsman, had for some time slackened his business energies—spending long periods (extending to six months at a stretch) in shooting and fishing—leaving the carrying out of business matters almost entirely in the hands of his partner, Mr. William Richards; and the announcement made early last year that the name of the firm had been changed to A. & W. Richards was doubtless construed by their clients as indicating what was an actual fact—viz., that the entire conduct of the business had devolved upon Mr. W. Richards. The sad event, therefore, will make no difference in the administration of the gas and water auctions to which Messrs. Richards, during their partnership of the last twenty years, have devoted their chief energies. It may be remarked that the deceased gentleman was for many years a member of the Evening Star Lodge, with which his brother is still connected.

THE DESIGN OF ATMOSPHERIC BURNERS.

By Alfred Mansfield, of Liverpool.

Among the many problems connected with the design of atmospheric burners of all kinds is the relationship of one orifice to another. I know of no tables which give this information in a manner which is of service to a busy man. I have been obliged to work them out for use in our laboratory; and I publish them in the hope that they will be of service to others. I give the diameter of orifices in inches and their discharging powers, commencing from 1-100th of an inch and ending at 1 inch.

Diameter of Tube. Inch.	Discharging Power.	Diameter of Tube. Inch.	Discharging Power.	Diameter of Tube. Inch.	Discharging Power.
·01	·000003927	·35	·028459006	·68	·149737384
·02	·000022030	·36	·03053749	·69	·155321824
·03	·0000612495	·37	·032701083	·70	·160992736
·04	·000125701	·38	·034955617	·71	·1668047450
·05	·00021945	·39	·037301373	·72	·17274081
·06	·0003462	·40	·039739037	·73	·17879855
·07	·00050895	·41	·04328975	·74	·184985262
·08	·00071099	·42	·044892819	·75	·191298624
·09	·00095439	·43	·047613274	·76	·197740142
·10	·0012417	·44	·050430274	·77	·204310018
·11	·0015758	·45	·053344937	·78	·211008430
·12	·0019589	·46	·056358364	·79	·217833146
·13	·002392824	·47	·059471646	·80	·224793031
·14	·002880047	·48	·062684304	·81	·231884606
·15	·00342788	·49	·066000462	·82	·239108236
·16	·00402140	·50	·069420208	·83	·246466096
·17	·00467918	·51	·072716956	·84	·253957638
·18	·00539807	·52	·076572534	·85	·261584117
·19	·00617942	·53	·080307165	·86	·269341352
·20	·00702494	·54	·084171856	·87	·277240719
·21	·00793630	·55	·088163192	·88	·285276714
·22	·00912483	·56	·092157208	·89	·293451529
·23	·009626805	·57	·096327063	·90	·301765246
·24	·01108112	·58	·100607694	·91	·310217927
·25	·01227163	·59	·105001214	·92	·31880625
·26	·0135362396	·60	·109504537	·93	·32754123
·27	·01487587	·61	·11412532	·94	·33641819
·28	·01629161	·62	·118860511	·95	·34543790
·29	·01778467	·63	·123732063	·96	·354601110
·30	·01934692	·64	·128677199	·97	·36390858
·31	·0208862225	·65	·13376656	·98	·37335499
·32	·02280796	·66	·138971019	·99	·38295387
·33	·0245669	·67	·144292267	1·00	·39269850
·34	·02686858				

The method of using these tables is as follows: In a ring or bar burner, it is well known that the total discharging power of the drilled holes must bear a definite relationship to the discharging power of the mixing-tube. Take for example an ordinary ring boiling-burner. It is decided to drill 70 holes ·11 inch diameter. What will be the diameter of the mixing-tube? If we refer to the above table, we find the discharging power of an orifice ·11 inch diameter is ·0015758. The total discharging power for 70 orifices will therefore be ·1103060. Glancing down the column of discharging powers, we find a single tube between ·60 and ·61 in diameter will have a similar discharging power.

It must be remembered that the discharging power of a mixing-tube varies according to its length. Also that mixing-tubes are not usually circular or smooth. It would be safe to make the diameter of the mixing-tube ·75 inch; but it must not be less than ·60 inch. Suppose this burner is found to work well, and will boil water with an efficiency of 60 per cent., and for some reason it is desired to use holes ¼ inch, or ·25 inch, instead of ·11 inch in diameter, and still retain the same mixing-tube and nipple. How many holes ·25 inch diameter should be drilled? The method is as follows: We have found the total discharging power of the 70 holes each ·11 inch diameter to be ·1103060. A reference to the table will show that the discharging power of an orifice ¼ inch, or ·25 inch, diameter is ·01227163. If we divide this into ·1103060, we find the result to be between 8 and 9. If eight holes are drilled ·25 inch diameter instead of 70 holes ·11 inch diameter, it will be found that identically the same structure of flame is the result. Or if a single tube is desired, it will be between ·60 and ·61 inch diameter.

Perhaps it will be found that this burner (which works so well) consumes 10 cubic feet of gas per hour. Its discharging power is ·1103060. If we divide 10 by ·1103060, we obtain a constant which is 9·06. Now, if we take any other size of burner, calculate its discharging power, and multiply by this constant, it will give the exact consumption of gas per hour in cubic feet for the same kind of flame, with the same quality of gas.

For the measurements of orifices, I use a steel tapered gauge made by Messrs. Chestermans, of Sheffield, which costs about 9s. It is marked on one side in 64ths and on the other in 100ths, and reads up to 1 inch. With this handy instrument, orifices can be measured to 1-100th of an inch with the greatest ease.

It will be seen that the table is of the greatest service for the following:—

1.—The correct calculation of the relationship between the issuing orifices and the mixing-tube.
2.—Having once designed a satisfactory burner, a smaller or

larger burner can be readily designed which will give exactly the same efficiency.

3.—If the gas consumption of one burner is found, with a certain quality of gas, the consumption for any other size of burner can be calculated with the greatest exactitude for the same quality of gas.

BELTON'S PATENT "FACILE" SYPHON.

In the entrance hall of the Institution of Mechanical Engineers last week, many gas engineers were interested in a model of this new form of syphon for gas-mains. It is the invention of Mr. J. C. Belton, of Chester, and is designed with the objects of minimizing the cost and trouble attendant upon the fixing of syphons, of more completely effecting the removal of the liquid deposited, and of decreasing the liability to leakage and to fracture of the casting by superficial pressure.

These objects are attained by making the syphon in the form of a "fish-bellied" pipe, having the usual sockets, or socket and spigot, at the ends. The body of the syphon is no wider than the diameter of the pipes to which it is connected. The depth at the centre is about three diameters of the pipe, and the length about 4 feet, so as to give ample capacity in the containing portion. The dip-pipe for emptying is fixed in the centre, and is of sufficient length to remove almost the entire contents; the curved shape of the bottom portion enabling this to be done more effectually than is possible with syphons having a flat bottom.

The only excavation required for fixing the "Facile" syphon is a curved depression in the bottom of the pipe-trench sufficiently deep to accommodate the segment-shaped casting; the ends being levelled to receive the adjacent pipes by rocking the casting in the required direction. A spadeful or two of earth thrown in the trench holds it in position while it is being "jointed up" and tested for soundness. When the trench is filled up, the soil readily conforms to the curves of the bottom, and makes a firm support, so preventing the fracture of the adjacent pipes by the weight of a syphon inadequately supported—a mishap not unknown to users of flat-bottomed syphons.

The economy of time and labour in fixing is a considerable item in the advantages claimed for the "Facile" syphon; the difficulties often met with in the fixing of flat-bottomed cylindrical or rectangular syphons being entirely obviated. The vertical cross section offers the maximum resistance to fracture by heavy traffic. The section is slightly modified for syphons above 10-inch size, so as to avoid unwieldiness. Length, depth, and terminal connections can be varied to suit special requirements; but standard patterns have been prepared for all sizes under 12 inches. Many expressions of appreciation of the obvious advantages of the syphon were heard from engineers who examined the model during the week, but not a word of adverse criticism.

Electric Lighting and Fire Risks.

At the congress of the Fire Brigade Officers held at the Guildhall, Westminster, last Thursday, Mr. Arthur Pordage, the Fire-Master in Edinburgh, read a paper on "Electric Lighting and Fire Risks." Reviewing the origin of fires caused by electric currents, the author said it was found that the majority resulted from the fusion of gas-pipes by a short-circuit being formed from charged electric wire tubing, metal beams or columns, and gas-tubing. The principal cause of these defects was, in his opinion, due to the metallic conduit system. It was his experience that not more than 2 per cent. of fires caused by defective electric circuits had been due to defects developed in wooden conduits. He accordingly advocated the use of wooden casing as against metallic conduits. Electric lighting and gas heating for domestic purposes were both now so absolutely indispensable to every-day life, that the safest means of wiring buildings were essential for the proper safeguarding of life and property against methods which tended to menace alike the success of electric domestic supplies and the buildings in which they were installed. As to the fire risks caused by electricity, he gave the following figures for London and Edinburgh during the past three years: London, total fires caused by electricity, 294, of which number 279 were returned as being due to defective electric circuits, seven to the overheating of electric lamps, and the remainder to minor causes. For Edinburgh, the total electric fires were 46, of which 35 were due to shorting of tubing on to gas-pipes, five to faulty flexible wires, and six to overheating and minor causes. The averages in other large towns were generally similar, proving that the diminution of electric causes of fires could only be attained by the adoption of really safe methods of distributing electric energy in buildings.

The Council of the London Chamber of Commerce, at their meeting on the 10th inst., elected Mr. Henry Adams, M.Inst.C.E., F.S.I., &c., as a member of the Arbitration Committee of the Chamber in addition to the Engineering Committee of which he has been a member for some years.

AMERICA AND THE NEW UNIT OF LIGHT.

We have received from the Acting-Director of the Bureau of Standards of the Department of Commerce and Labour at Washington (Mr. E. P. Rosa) an announcement which is being issued by the department relative to the adoption by the United States, in conjunction with Great Britain and France, of the new unit of light. The first portion of the circular consists of the memorandum by Dr. R. T. Glazebrook, F.R.S., the Director of the National Physical Laboratory, Teddington, which was reproduced in the "Journal" for the 18th ult. (p. 439); and the following comments are made upon it.

The above announcement marks an important step forward in the history of photometric measurements. For many years the British parliamentary candle was the unit recognized in this country [America]; but the lack of precision in practical photometry did not permit its value to be very accurately expressed or reproduced. In recent years, the gas industry has employed the one-candle power sperm candle, the ten-candle power Harcourt pentane lamp, the Hefner lamp, and various secondary standards; the electrical industry has employed incandescent electric lamps, either certified by the Bureau of Standards or rated in terms of standards that are consistent with those of the Bureau. The unit of the Bureau has been maintained very constant, as shown by frequent comparisons with the standards of France, Germany, and Great Britain, but differed appreciably from the British unit, and hence from the unit employed by most of the gas companies in America.

The Bureau of Standards took the initiative several years ago in bringing about international uniformity in the unit of light, by sending its representatives abroad, with copies of its standards, to determine more accurately the relative values of the units of the several European countries, and to urge the adoption of an international unit. In this country, the American Institute of Electrical Engineers, the American Gas Institute, and the Illuminating Engineering Society have acted together in support of the movement, and have voted in advance to recognize the new unit of candle power. In England, the National Physical Laboratory has secured the endorsement of the London Gas Referees and the Institution of Gas Engineers. The union of the three national standardizing institutions of America, France, and Great Britain in maintaining a common unit of candle power, and the co-operation of the German Reichsanstalt in redetermining from time to time the ratio of the Hefner unit to the common international candle, assures the highest attainable constancy for the new unit of light.

Unfortunately there is no primary photometric standard that is sufficiently constant and reproducible to be generally accepted as an international standard. France, Germany, and Great Britain each has its own primary flame standard; and a great deal of effort has been expended in attempting to determine accurately the relations between them. Until the flame standards themselves are better understood, however, and the atmospheric and other conditions more perfectly controlled, the unit of light cannot be preserved as accurately by primary flame standards as by incandescent electric secondary standards. The latter, when well made, properly seasoned, and carefully measured, permit comparisons to be made (using the means of many settings on several lamps) with excellent precision; the lamps themselves being constant enough, and the precision of measurement high enough, to fix the final values to about one or two tenths of 1 per cent. There is good reason to believe that in this way the international unit of light can be preserved so nearly constant that any inevitable drift occurring one way or the other would be too small to detect with certainty by any of our present flame standards in many years. The Bureau of Standards will continue to standardize flame standards by the electric standards, and will also carefully investigate the more important flame standards. Similar tests and investigations will also be made in Europe; and, if any appreciable drift does occur, it will sooner or later be detected.

Careful distinction should be made, in this connection, between a unit and a standard. An international unit maintained by the co-operative effort of several national standardizing institutions, and checked from time to time by means of all the best primary standards in use, is more likely to be maintained constant than if it were defined to be represented by any single primary standard, unless such a primary standard were reproducible to a very high degree of precision. Such a unit can be continued permanently, even though all present primary standards are ultimately superseded by better ones. The Hefner lamp as a convenient flame standard will not be displaced in America or any other country which adopts the international candle as its unit of light. Uniformity among different countries and continuity of value are prime necessities with respect to the unit. But the particular standard by which the unit is realized in practice is largely a matter of convenience and circumstance. In the photometry of electric lamps, electric standards are most suitable. In gas photometry, one form of flame standard or another will be employed according to circumstances. It is not expected that all countries of the world will at once adopt the proposed international candle as their unit of light. Those countries which already have the Hefner unit in general use may prefer to continue it. But if all

countries which have a unit differing appreciably from the Hefner will adopt the international candle as their unit, there will then be only two units in use throughout the world, and they will have the ratio 9 : 10. This would result in a distinct gain, both in the practice of photometry and in definitions and nomenclature.

The effect of this change of 1·6 per cent. in the unit of the Bureau, which is in general use for electric lighting throughout the country, is to raise the candle power rating and decrease slightly the watts per candle of electric lamps. A 16-candle power lamp will give 16·26 candles in the new unit, or a 16-candle carbon filament lamp burning at 110 volts will give 16 candles on the new basis at 109·69 volts. The change, though small, is important in the photometry and rating of lamps.

The new unit of candle power being in agreement with the present English unit as represented by a ten-candle power standard pentane lamp, there will be no change in the unit of light now employed by those gas companies who use pentane lamps, provided they are in agreement with the English standard. But as pentane lamps may differ slightly from one another, even when burned under the same conditions, it is desirable, for the sake of greater uniformity, to have them standardized in terms of the standard candle of the Bureau. These variations, amounting to from 1 to 5 per cent., are generally in the same direction—that is, the lamps if not correct usually give less than 10 international candles under standard conditions when burning in a pure atmosphere at a normal barometric pressure of 76 centimetres of mercury and an atmospheric humidity of 8 litres of water vapour per cubic metre. In anticipation of this change, some of the largest gas companies in the United States have already had their pentane and Hefner standard lamps standardized by the Bureau in terms of the new unit.

Gas standards will hereafter be certified in terms of the international candle. Electric standards will be certified in terms of the old unit until July 1, 1909, unless otherwise requested. On July 1, the new unit will be adopted by the Bureau of Standards in the certification of electric standards; and it is hoped that manufacturers of electric lamps will adopt the new unit as soon thereafter as possible. The Bureau recommends that all gas and electric companies, all photometric laboratories, and manufacturers of electric lamps in the United States should adopt the new unit of candle power, if possible, not later than Jan. 1, 1910.

Determination of Thorium in Monazite Sand.

In an article in an Italian chemical publication, Signor V. Borelli dealt with the above subject. According to an abstract in the "Journal of the Society of Chemical Industry," about 2 grammes of finely-powdered monazite are treated in a platinum crucible with 5 c.c. of sulphuric acid of sp. gr. 1·84 and a little hydrofluoric acid. The crucible is fixed in a larger porcelain crucible by means of a ring of asbestos, and is heated gradually, so that the hydrofluoric acid is evaporated in from one to two hours, and the sulphuric acid in from four to five hours. When fumes are no longer evolved, the platinum crucible is allowed to cool, the greater part of the contents detached with a spatula, and dissolved in about 10 c.c. of hydrochloric acid. After diluting with water to 50 c.c. to 60 c.c., the solution is decanted through a filter. The crucible is now half filled with concentrated hydrochloric acid (2 : 1), heated for a few minutes on the water-bath, the contents poured into a basin, the residue again digested with hydrochloric acid, and then the crucible carefully washed out—the whole of the contents being received in the basin. The contents of the latter are heated for 15 minutes on a boiling water-bath, diluted with water, the solution decanted through the same filter as was used previously, the residue digested with concentrated hydrochloric acid, and the sequence of operations repeated three or four times, until only a small quantity of a greyish-white sandy residue, insoluble in dilute acid, is left. The solution (about 300 c.c.) is heated to boiling, treated with ammonia until the greater part of the acid is neutralized—*i.e.*, until the precipitate formed re-dissolves only with difficulty—and then to the boiling solution crystallized ammonium oxalate is added in small quantities at a time, until the precipitation of the rare earth oxalates is complete. After a few hours, the solution is decanted through a filter, and the precipitate washed by decantation and on the filter with a dilute solution of ammonium nitrate. The precipitate is taken up with 15 c.c. to 20 c.c. of nitric acid, heated to boiling, and potassium permanganate solution added till a pink colour persists. The solution is boiled to destroy the excess of permanganate, ammonia is added until the solution is neutral or just faintly acid to litmus, and then 10 c.c. of a 3 per cent. solution of pure hydrogen peroxide added, and the whole heated for a few minutes at from 60° to 80°C. The precipitate of thorium peroxide, coloured a more or less intense orange by cerium peroxide, is filtered off, and washed with a dilute solution of ammonium nitrate. The thorium peroxide is freed from the impurities it contains by re-dissolving in nitric acid and precipitating again with hydrogen peroxide. It is again washed with ammonium nitrate solution, ignited in a platinum crucible, and weighed.

Those among the many friends of Mr. John Bond, the Engineer and Manager of the Southport Gas-Works, who were present at the meeting of the Institution last week, were pleased to be able to congratulate him upon his engagement, which was then announced, to Miss Margaret Hankinson, of Alvechurch.

COMPRESSED-AIR DRILLING OF A LIVE GAS-MAIN

And Attaching a 24-Inch T-Piece, while under Pressure.

In executing his constructional work, it is the duty of the engineer to do it with economy, combined with dispatch and safety to those employed on the work. To attach a T-piece and drill a large main while under pressure, without loss of gas, and with safety to the men, is at any time an interesting piece of work; and an instance that recently came under our notice—where the work was done with unusual expedition, in connection with the Eastbourne Gas-Works—appealing to us as being especially interesting, we asked Mr. John Hammond, the Resident Engineer and Manager, to allow us to describe and illustrate the operation.

Fig 1.—The Drill attached to the Valve.

The trunk main concerned is a 24-inch one supplying the town; and upon it a junction of equal diameter was required. A new governor has been put down at the works, through which it was necessary to supply the town; and to connect up to the trunk main a 24-inch Tpiece had to be inserted, and the main bored

Fig. 2.—The Valve and Clip being attached to the Trunk Main.

under pressure. This was successfully carried out by the special drilling machine (seen in fig. 1) by Mr. A. O. Ruscoe, of Messrs. Ruscoe and Co., Queen Anne's Chambers, Westminster, S.W.

Here we have illustrated a method whereby this class of work can be mechanically accomplished in about one-third the time ordinarily occupied by the old method of drilling by hand labour, as shown in fig. 2. In carrying out the work, Mr. Hammond introduced a small compressed-air motor (seen in fig. 1), in place of hand labour, to operate the drill.

In fig. 2, it will be observed how the valve and the clip were attached to the trunk main; and in fig. 1 how the drill was attached to the valve. In fig. 3 is shown the core that was extracted by the drill on the completion of the work. The valve was closed before the drill cover was removed; and the whole work was accomplished without even the smell of gas being once noticed in the trench.

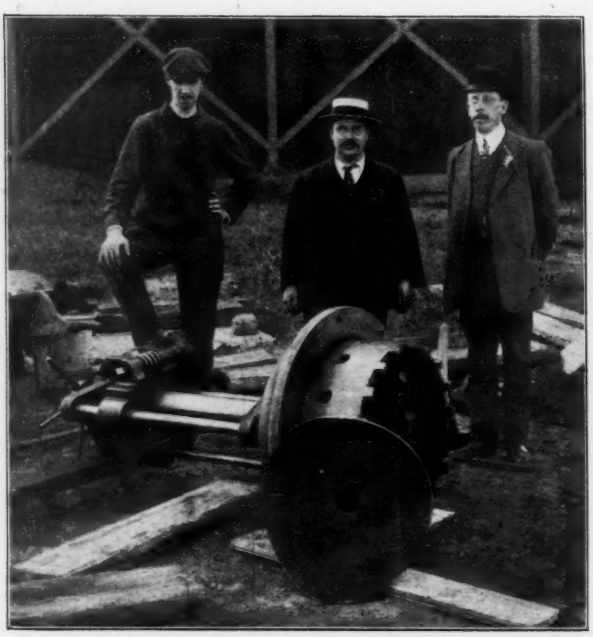


Fig. 3.—The Core extracted by the Drill.

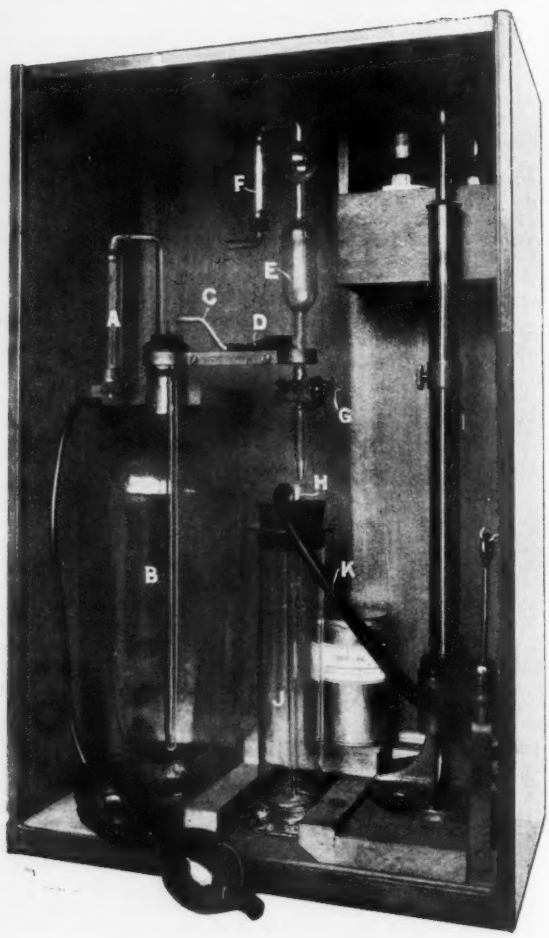
The application of the compressed-air motor for the working of the drill has more than one advantage to recommend it. It considerably shortens the time required for the whole operation; and on the score of safety in going up to a live main, this method of doing the work leaves nothing to be desired, as there is no possibility of escape of gas. This is an important point in these days, when it has become essential to work gas at higher pressures, and with the demand for gas going on throughout the twenty-four hours. There are Compensation Acts in operation now; and in pre-Compensation Act days, gas was distributed at lower pressures. Workmen need greater protection in these times of higher pressures; and when dealing with a live main, compressed-air drilling from this point of view, as well as from all all others, is something to be commended. In many gas-works there are air-compressors now installed; and if not a portable air-compressor is always serviceable on a works. This illustration of how this 24-inch connection was made with the 24-inch live main at Eastbourne will, we think, be suggestive to other gas engineers when engaged on similar operations, which demand expedition without loss of gas.

We thank Mr. Hammond for permission to publish these particulars and the photographs.

Brussels International and Universal Exhibition, 1910.—Our readers may remember that a Royal Commission has been appointed to take charge of exhibitions to be held in Brussels from May to October next year, and at Rome and Turin in 1911. H.R.H. the Prince of Wales is President, and the Commission have permanent offices in Queen Anne's Chambers, Westminster, where the superintending official is Mr. U. F. Wintour, the Secretary and Commissioner-General and Director of the Exhibitions Branch of the Board of Trade. We learn from particulars which have been published by the Board that the British Government have secured for its section what is considered to be the most prominent position in the Brussels Exhibition. It amounts to 203,140 square feet, of which 150,640 square feet are in the Industrial Hall and 52,500 square feet in the Machinery Hall. The main gallery running through the British Section is 510 feet long and 98 feet wide; and there are four other parallel galleries 56 feet wide which lend themselves to the formation of attractive courts for the display of different classes of manufactures. The officials of the Royal Commission will undertake the entire handling of the exhibitors' goods within the Exhibition, and provide show-cases, stands, &c., without charge beyond the cost of the space.

ESTIMATION OF CARBON DIOXIDE IN AIR.

The dangers associated with the presence of a large proportion of carbon dioxide in air have long been recognized by scientifically trained minds; but up to the present day the strictly physiological limit has never been actively enforced. While factory and other regulations have led to the apportioning of so many cubic feet of air-space to an employee in a workshop, the purity or impurity of the air which is being breathed is left almost unconsidered. Of late years, the principle of "change of air per worker," compared with "air space per worker," has been more and more recognized; and one of the factors which have somewhat delayed improvements has been the absence of a quick, but at the same time simple and accurate, method for estimating the carbon dioxide present in the air from any part of a room. It is claimed that the three essential conditions of rapidity, simplicity, and accuracy are satisfied in the "York" air-tester, which has been patented and is being manufactured by Messrs. J. J. Griffin and Sons, Limited, of Kingsway. This, as will be seen from the accompanying illustration, consists of a wash-bottle containing a definite quantity of a reagent which reacts with carbon dioxide, and a pump by means of which a measured volume of air is passed through the reagent in the wash-bottle.



The method of manipulating the tester is as follows: Before making the solution required for the test, the protecting tubes A and F must be filled with soda-lime. These tubes serve to prevent access of atmospheric carbon dioxide to the solution. The solutions required are (*a*) a strong or stock solution of baryta, from which is made (*b*) a weak solution used for the test. The operator should take 25 grammes of the pure crystallized barium hydroxide (powdered) and place in a litre bottle; add a litre of distilled water; cork up, and shake well until the crystalline baryta is completely dissolved, or only the merest trace of barium carbonate is left in suspension. It is very important that the rubber stopper should fit tightly, so that no air can gain access to the solution. This bottle contains the laboratory stock solution, and need not be carried about with the apparatus. To prepare the weak solution, it is necessary to first remove the fittings from the bottle marked B, and then place in it 2 litres of distilled water and about 1 c.c. of a solution of phenol-phthalein (containing 1 gramme of phenol-phthalein per 100 c.c. of alcohol). By means of the 5 c.c. graduated pipette, small quantities of the strong baryta solution are run into the 2 litres of water in the bottle B until, after thorough shaking, the solution just assumes a permanent pink tint. The carbon dioxide which was originally

present in the distilled water has now precipitated. As soon as this pink tint is permanent, the operator adds a further 3·3 c.c. of the strong baryta solution, inserts a cork, and shakes thoroughly. He removes the cork, and immediately fits the rubber stoppered protecting tubes and pipette (A, C, E, F), in position.

The solution now requires calibrating against atmospheric air. The apparatus is placed in front of an open window on the windward side of the room, in such a position that a current of fresh air is passing over it. The outlet-tube of the pump is connected to the absorption vessel J by means of the rubber tube K, and the inlet-valve to a long glass tube, the open end of which projects several feet out of the window, and is supported by passing through a ring supplied ready for attachment to the body of the pump. In this way a sample of pure air can be procured. The pump is worked several times up and down, so as to clear the apparatus of any impure air. Then 25 c.c. of the solution in the bottle B (conveniently raised into the pipette by means of the small blower attached at A) are placed in the absorption vessel, and a drop or two of phenol-phthalein solution added through the tube H. The vessel J and its contents are then thoroughly shaken (the tube H being closed by the thumb) for a quarter of a minute, after which one volume of air from the pump is discharged into the vessel, which is again thoroughly shaken for the same length of time. This process is repeated until the solution just becomes colourless, which should occur after 14 strokes of the pump, *plus* one added for the air present in the vessel at the commencement. As the accompanying table has been drawn up on a basis of 15 strokes for pure air, it is necessary to adjust the strength of the solution until it responds to 15 strokes. If the solution is either too weak or too strong, it is best to start again with another 2 litres of water in the bottle. With a little practice it becomes easy to hit off the correct amount of strong solution required.

Having adjusted the solution to the required strength, the apparatus can be used to test the amount of carbon dioxide in the air of any room. The inlet-tube should be placed at some distance from the operator, at least 3 feet from any person in the room, and a like distance away from any wall. In an ordinary test of a workroom, the sample should be taken at about the breathing level. Reference to the following table will give directly the parts of carbon dioxide per 10,000 present from the number of strokes:—

Strokes of Pump.	Parts CO_2 per 10,000.	Strokes of Pump.	Parts CO_2 per 10,000.
15	3·6	7½	8·7
14	4·0	7	9·3
13	4·5	6½	10·1
12	5·0	6	10·9
11	5·6	5½	11·7
10½	5·9	5	12·7
10	6·3	4½	13·8
9½	6·7	4	15·0
9	7·2	3½	16·4
8½	7·7	3	18·0
8	8·2	2½	19·8

A note of the general condition and temperature of the atmosphere, of the air space available, the number of people present, and the presence or absence of gas-jets and open windows, should accompany the result of this test. In testing exceptionally foul air, it will be found that a solution of twice the usual strength gives results almost exactly corresponding with twice the carbon dioxide content quoted in the above table.

ARTIFICIAL LIGHTING AND ULTRA-VIOLET RAYS.

In the "JOURNAL" for March 31, 1908 (p. 829), some particulars were given of investigations by Herren F. Schanz and C. Stockhausen into the effect of artificial lighting on the eyesight. Their conclusions were that eye troubles were due to the ultra-violet rays emitted by light sources, and also to their brilliancy. That the troubles were not imaginary was shown by the fact that Herr Stockhausen himself experienced severe inflammation of the eyes as the result of working with an electrical arc lamp, though he wore spectacles—glass having been considered some protection against injury due to this cause. His experience has not been singular, for many cases of similar character have been cited by others.

Research work was undertaken by both Herren Schanz and Stockhausen for the purpose of ascertaining how far ordinary glass absorbs ultra-violet rays. They found glass lamp shades, spectacles, and the like, afforded very little protection from the powerfully active rays lying between 0·3 to 0·4 μ. They do absorb, it would seem, rays of shorter wave-length than 0·3; but the latter are of less consequence, since they possess very little penetrating power. Although the lens of the human eye is able to protect the retina from the stimulus of ultra-violet rays, it is a question whether strong illumination by these rays, as derived from artificial light, is not responsible for eye-strain and other troubles, and possibly for the initiation or acceleration of cataract. It is certainly noticeable that the eyes tire more quickly in artificial as compared with daylight; and, as was pointed out, diffused daylight is not very rich in ultra-violet rays, since the atmosphere acts as an absorbent. This, it may be remarked parenthetically, has been confirmed by various authorities.

Herren Schanz and Stockhausen considered it was advisable to employ some species of glass which would absorb the objectionable rays from artificial light sources; and they were successful in producing a glass (known as "Euphos") suitable for the purpose. The photographs of the spectra of an electric arc light, variously shaded by clear and opal globe, by red "observation glass," and by "Euphos" glass, indicated remarkable differences. Whereas with clear and opal glass very imperfect absorption (varying in favour of the opal) was shown, with red "observation glass" a considerable reduction took place, and with "Euphos" practically no ultra-violet rays would appear to be transmitted; while the visible spectrum was not affected by more than about 3 per cent. The same phenomena are indicated by the photographed spectra of Nernst and metallic filament lamps. The above particulars were embodied in a paper read before the Verband Deutscher Elektrotechniker last June; and in the discussion which followed, corroboration was afforded as to the bad effects of severe exposure to ultra-violet rays. The suggestion was made, however, by one or two members that in ordinary circumstances results were not serious—one speaker (Herr Haagn) considering that the eye, accustomed to daylight and its ultra-violet rays for long ages, could not be very easily injured. Herr Stockhausen's obvious reply was that, although sunlight contained ultra-violet rays, very little of them reached the eye in the case of diffused and reflected daylight by which ordinary operations were carried out.

The work of Herren Schanz and Stockhausen has been here further referred to, and more fully discussed, in view of the fact that Dr. Voege has, in the "Elektrotechnische Zeitschrift," somewhat traversed the ground taken by them. This gentleman admits that serious injury to the eye may be caused by the ultra-violet rays as in the mercury quartz lamp; but, while he acknowledges it is also caused by lamps of great intrinsic brilliancy, he is doubtful whether it is solely due to the ultra-violet element. He therefore questions the necessity of using special glass for artificial lights generally, since the eye has been gradually developed and adapted to natural light, which contains the rays objected to. Dr. Voege, however, proceeded to investigate the relative strength of the rays in artificial and daylight. To this end he prepared two similar surfaces illuminated respectively by daylight and by the artificial light under test, until the brightness of both appeared to the eye equal. A photographic plate was then introduced, and a negative of the bright image obtained—by this means getting a comparison of the chemically active ultra-violet intensity rather than the brightness of the two surfaces of light. The plates were developed under the same conditions; the exposure and strength of the developer being so selected that the blackness of the negative could be regarded as roughly proportionate to the intensity. A quartz lens which transmits ultra-violet light was used to produce the image. Provision was also made for the insertion of a piece of clear glass, 2 mm. thick, so as to cover the upper half of both patches of light. A solution of nitrosodimethyl aniline was used for the purpose of absorbing light of wave lengths lying between 0·5 and 0·37 μ, but of transmitting light from the H and K lines as far as about 0·2 μ.

Dr. Voege, obtained negative photographs of daylight and of artificial lights such as the Nernst, miniature arc, carbon, and metallic filament lamps, and the incandescent gas light; and these appeared to indicate that for a given physiological brightness a surface illuminated by diffused daylight was richer in ultra-violet rays than those by the artificial illuminants referred to. He concluded therefore that in the case of artificial light sources, so far as illuminated surfaces are concerned, the eye, under conditions of equal brightness, will be subject to less ultra-violet energy than in the case of daylight. It is acknowledged, however, that injury may possibly arise from ultra-violet rays if the eye looks straight at a brilliant, unshaded light; but where direct light is screened and natural daylight conditions are imitated there is no reason to fear injury from reflected ultra-violet light.

So far as direct light is concerned, Dr. Voege obtained spectrophotographs of natural and artificial light sources; and these indicated that the spectrum of direct sunlight extended into the ultra violet further than that of any of the artificial lights. The doctor thinks it possible that where eye-fatigue is experienced it is due rather to want of uniformity in the illumination, or, in the case of the flame arc, by reason of contrast—the background being relatively black—and that in the case of artificial illuminants generally special protective glasses were unnecessary.

The substance of the above appeared in the pages of our American contemporary "The Illuminating Engineer," and recently, through the correspondence pages of that magazine, Herren Schanz and Stockhausen, followed by Dr. Voege, have further discussed the matter. We take the liberty of quoting some of the points advanced. The first-mentioned gentlemen remark that the injury done to the eyes by ultra-violet light is shown by the existence of such a trouble as electrical ophthalmia; and they further quote the evidence recently given by Professor Birch-Hirschfeld. The facts are instanced that, under ordinary conditions, the ultra-violet rays in daylight can produce irritation, and in some cases eruptions of the skin; and they adduce cases of "glacier burning" in mountainous districts, "snow blindness," and "red vision," ascribed to the reflection of ultra-violet radiation from the snow in polar regions.

Daylight ultra-violet rays are variable, and daylight illumination is of a diffused character from which almost all the ultra-violet light had been eliminated by successive reflection. Where daylight is strong, protection is sought by headgear to screen the eyes, and by other methods. The writers point out that corresponding

protection from direct rays of artificial lights is usually wanting; and this distinction had not been sufficiently appreciated by Dr. Voege. Again, since the ratio of ultra-violet to the visible energy in daylight admittedly varies with climatic conditions, it is contended that an attempt to use so variable a source of comparison in a rigid physical proof is unsatisfactory. Herren Schanz and Stockhausen remark that, according to Dr. Voege, the solution of nitrosodimethyl aniline, employed with the object of eliminating the visible rays, absorbs rays between 0·5 μ and 0·37 μ, and yet allows those between the H and K lines and 0·2 μ to pass unchecked. Yet the H line corresponds with a wave-length 0·4 μ, and the K with 0·397 μ. The visible spectrum is stated to end at 0·397 μ. By using the suggested solution, Dr. Voege cuts out an intense ultra-violet band occurring in the spectra of the arc light, and of much greater consequence than the simultaneously absorbed ultra-violet region of the daylight spectrum.

Dealing with Dr. Voege's conclusion that the spectrum of sunlight extends further into the ultra-violet than the spectrum of artificial illuminants, it is remarked that Cornu failed to detect wave-lengths further than 0·295 μ, while Rowland placed the limit at 0·300 μ. On the other hand, light of wave-lengths as small as 0·2 μ have been proved to exist in the arc light spectrum. Even if artificial illuminants were invariably surrounded with a glass envelope, ultra-violet rays of 0·3 to 0·4 μ would be allowed to pass unhindered; only those below 0·3 μ being, in general, absorbed by glass of the ordinary variety.

To this interesting contribution, reply was made in the March number of the "Illuminating Engineer." Dr. Voege does not dispute the existence of eye troubles and of inflammation caused by close proximity to arc lights, but thinks such exceptional cases should be left out of consideration. He contested the recommendation that every arc, glow, or incandescent gas-lamp should be shaded with "Euphos" glass. Referring to the contention that daylight as the standard was too variable, he remarks that his experiments were carried out in Hamburg on successive days, about ten a.m., in July, and under a cloudless sky; and the variation could not be very great. He admits, as had been suggested, that optical intensity and photo-chemical intensity are different factors; but the degree of ultra-violet radiation in the two illuminants could only be compared by observations carried out at equal optical brightness. Dr. Voege combats the suggestion that his solution cut off the intense ultra-violet band in the arc light spectrum; and he describes an experiment which led to the conclusion that, for a given photo-chemical intensity of the total radiation from sunlight and the arc lamp, the rays between 0·3 and 0·366 μ have a greater relative effect in the former case than in the latter. It is then pointed out that wave-lengths as short as 0·2 existing in arc light need not be considered, since these very short waves are absorbed by the encircling glass globe. Dr. Voege explains that his experiments were not purely undertaken for the purpose of disproving the contentions advanced; but he regrets that Herren Schanz and Stockhausen should have published recommendations which, on a still undecided question, may cause anxiety to the general public.

The whole of the discussion is very interesting, particularly when read in conjunction with Dr. Nichols's recent paper contributed to the Illuminating Engineering Society (see "JOURNAL" for Sept. 22, 1908, p. 790), in which the consideration of daylight (with the atmospheric absorption effect) and also of artificial light sources is dealt with in considerable detail.

CORROSION OF OIL-TANKS.

Of recent years, much attention has been given by gas and water engineers to the electrolytic corrosion of iron, owing to the injury done to gas and water mains by stray electric currents. In these cases, the electric current causing electrolysis reaches the body damaged from without; but attention has recently been drawn to corrosion of iron structures due doubtless to electrolysis, but for which no current from without was responsible. Three such cases have been described in a paper by Mr. Knudson at a recent meeting of the American Electro-Chemical Society, and reported in Vol. XIV. of their "Transactions," from which the following abstract has been made.

The corrosion took place in oil-storage tanks, two of them being in gas-works and one in an oil-works. The two gas-works tanks were 35 feet in diameter and 16 feet high, made of riveted sheet steel plates, 11 inch by 5 inch and $\frac{1}{4}$ inch to $\frac{3}{8}$ inch thick, having a pipe 6 inches from the bottom serving both as inlet and outlet. The tanks were enclosed in a concrete wall, and had concrete foundations. As they were leaking, the oil was drawn off, and a sediment resembling soft soap removed, when the bottoms were found to be badly pitted. Examination showed that the pitting started inside the tank, and tapered downwards, causing holes as large, in some cases, as $\frac{1}{4}$ to 1 inch in diameter. In both tanks, the pitting was confined to the same areas, following the line of intake and spreading out at the opposite sides. Samples of water from the bottom of the tanks gave on analysis 1·69 per cent. of mineral residue consisting chiefly of sodium salt. In one tank, oil had been standing about a year; in the other, slightly longer. As neither exterior corrosion nor any current entering the tanks could be detected, the corrosion was not to be attributed to stray currents, though such currents were known to pass through the yard. The corrosion in the tank at the Standard Oil-Works was similar, but so extensive that the tank had to be rebottomed. It is noteworthy that the sides of both of these tanks showed no signs of corrosion.

The cause of corrosion suggested by Mr. Knudson is as follows: During the process of refining, the crude oil is treated first with sulphuric acid and washed with water, and then with caustic soda; being again washed to remove all traces of it. Should either of these washings be imperfect, traces of acid or alkali may remain, as shown by the analysis given above. In addition, sea water could easily find its way into the oil during shipment, as well as rain water during transit to the works. These, added to the soda, would form, on standing, a layer of an electrolytic liquid upon the bottom of the tank. Potential differences, caused by the impurities or uneven composition of the steel, would be set up; forming a series of galvanic couples, which would continue in action, causing eventually holes in the steel.

Attention has recently been drawn to the influence of surface abrasion as a factor in corrosion—a cut or scratch seemingly serving as a nucleus for corrosion; and in these particular cases it was noticed that the rivet-heads, which would be easily abraded during riveting, suffered severely. A suggested remedy was the use of a bichromate solution, which has been recommended as a protector of iron by Dr. Cushman. It has also been suggested to cover the bottom of such tanks with a layer of cement; but it is doubtful whether this would be sufficiently impervious to the electrolyte.

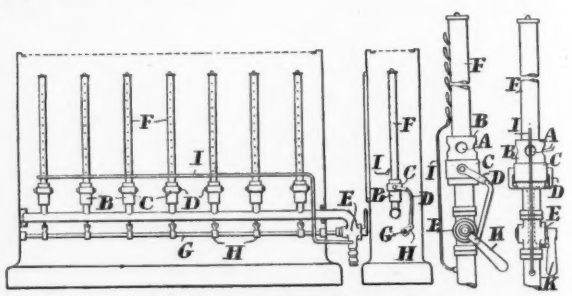
REGISTER OF PATENTS.

Controlling Gas-Burners for Stoves.

KOSCH, C. T. A. & O., of Budapest, Hungary.

No. 11,360; May 25, 1908.

The gas-stove constructed according to this invention consists of vertical burner-tubes closed at their upper ends and having along their cylindrical surface a series of small burner openings—each tube being provided in the proximity of the lowermost burner openings with a lighting jet.



Kosch's Stove-Burner Controller.

The air supply holes of each bunsen burner are formed in a tubular part B, on which is mounted a sliding ring C. To the ring is pivoted a fork D, connected to the gas-supply cock E in such a manner that, in closing the cock, the ring is slid up over the holes, and closes them so that air is no longer allowed to enter the burner. By this means the formation of an explosive mixture in the burner-tube F is prevented, and the lighted gas-jets will be extinguished without any noise. In opening the cock the ring is moved down again by the fork, so as to uncover the holes and allow the burner to operate like a bunsen.

In the main construction shown, a shaft G is mounted in the stove casing and connected directly to the plug of the cock so that it is rotated by the rotation of the plug. At each burner there is fixed on the shaft a lever H connected with the lower end of the fork D. The stove is shown with the gas supply turned off; but, by turning on the cock E, the shaft G is correspondingly rotated, and the levers H draw down the forks D, and by means of these the rings C, so as to cause the latter to uncover the air supply holes of the burners. The burner-tubes are arranged vertically, so that the lighting jet I need be provided only at the bottom hole of the burner. On lighting the gas at this hole, the whole of the gas-jets of the burner light automatically.

In the modified form shown as applied to a single burner, the fork D is connected to the handle K of the cock.

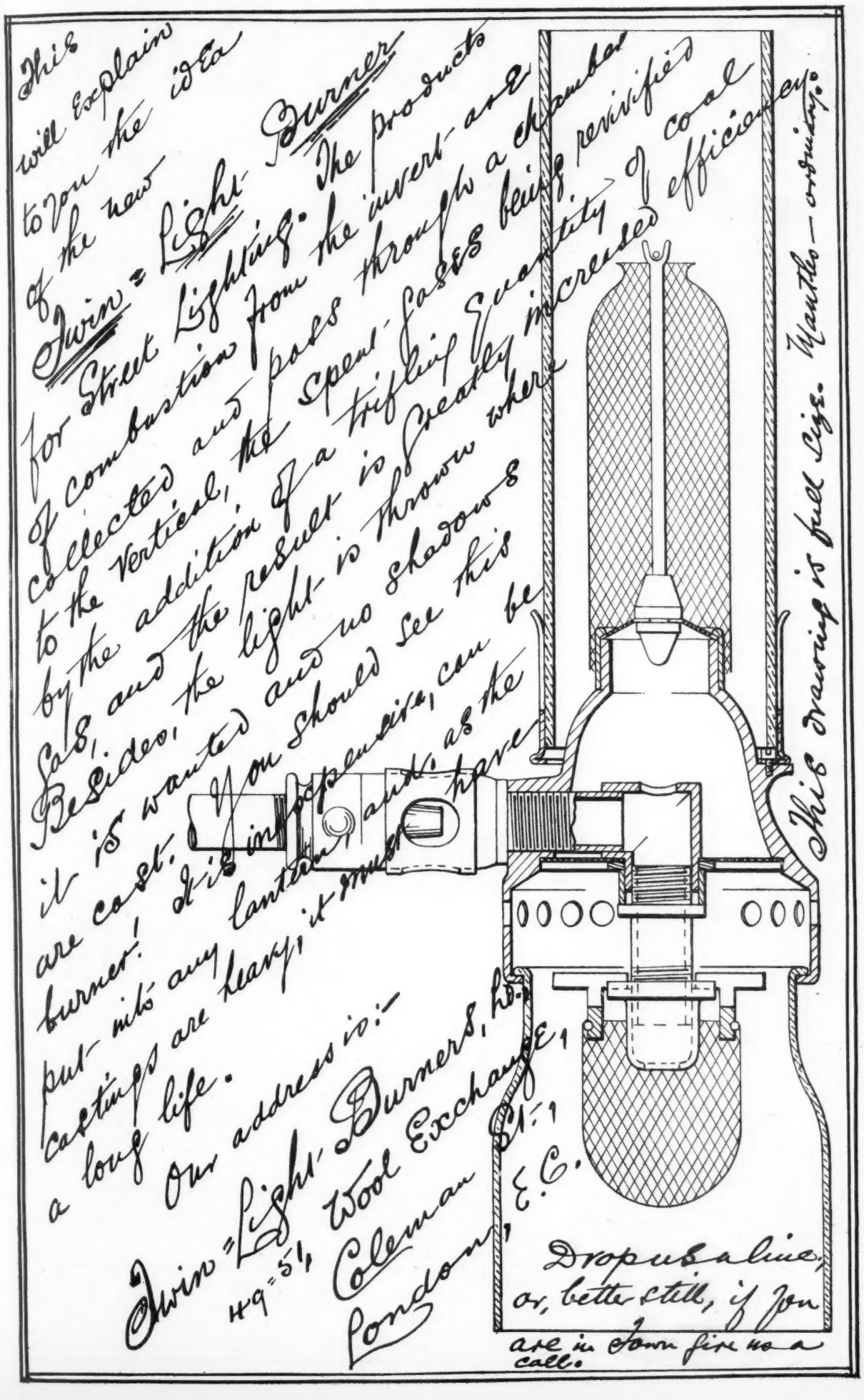
Inverted Incandescent Gas-Burner.

FRANCIS, A. S., of Farringdon Road, E.C.

No. 11,635; May 28, 1908.

This invention relates to inverted burners of the bent-tube type, with the object of producing a burner having an improved appearance and so arranged as to hide the unsightly bent-tube, to keep the greater portion of the bunsen tube cool, and to improve the mixture prior to its reaching the tip of the burner.

In the employment of a bent-tube burner in connection with a globe ring of standard size, the patentee points out, several difficulties present themselves. Firstly, if the horizontal limb of the burner be straight, and it is desired for the vertical limb to depend centrally of the ring,


This will explain to you the idea of the new Swin-Light Burner for Street Lighting. The products of combustion from the inverted are collected and pass through a chamber by the addition of a trifling quantity of coal gas, and the result is greatly increased efficiency. Besides, the light is thrown where it is wanted and no shadows are cast. You should see this burner! It is inexpensive, can be put into any lantern, and as the castings are heavy, it ensures a long life.
Our address is:-
Swin-Light Burners, Ltd.,
49-51, Wood Exchange,
Coleman Street,
London, E.C.
This drawing is full size. Mantle — ordinary.
Drop us a line, or, better still, if you are in town give us a call.

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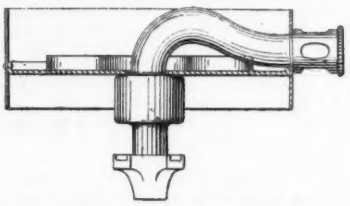
it is necessary to prolong the horizontal limb beyond the globe ring in order to obtain the requisite length of mixing-tube. Therefore, with such a construction, the nipple chamber would stand out from the globe ring and become unsightly. It has been heretofore proposed to surround such a burner with a deep globe ring; to make the burners with an upward loop in their horizontal limb; and to provide a perforated diaphragm on the globe ring the imperforate portion of which was arranged below the bent burner-tube to protect it.



Francis's Bent-Tube Inverted Burner.

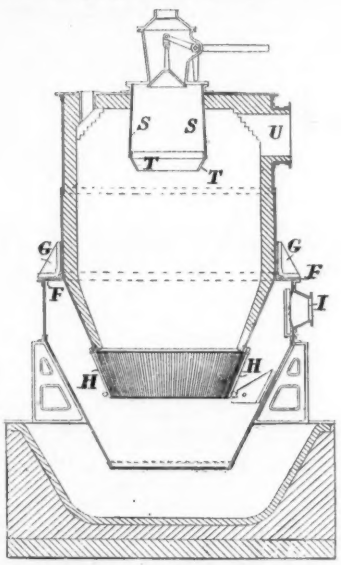
The present invention, however, consists in masking a bent-tube burner, having its horizontal member looped or sinuous in order to bring the nipple chamber close up to the globe ring, by means of a globe ring (as shown) of such a depth as to mask the bent and looped part of the burner, which is protected by means of a diaphragm arranged in the ring. Subsidiary features of the invention consist in arranging a known form of secondary mixing-chamber just beneath the diaphragm of such a burner, and in providing a particular formation of a known type of air regulating sleeve to the nipple chamber.

Gas-Producers.

Bone, W. A., of Leeds University; and Wheeler, R. V., of Altofts, near Normanton.

No. 17,103; Aug. 14, 1908.

This invention relates to the construction of gas-producers in which a mixture of heated air and steam is passed through incandescent fuel—specially adapted for the production of a gas relatively rich in carbon monoxide and low in the proportion of hydrogen.



Bone and Wheeler's Gas-Producer.

In the vertical section of the producer shown, the upper portion of the outer shell is cylindrical and the lower portion conical. The height of the cylindrical portion is half, or thereabouts, that of the conical portion. The inner shell is also formed of an upper cylindrical portion and a lower conical portion. The height of this cylindrical portion, however, is two-and-a-half times or thereabouts the height of the conical portion. Both portions of the inner shell are lined with fire-brick. The upper end of the cylindrical part of the outer shell is about level with the junction of the cylindrical and conical parts of the inner shell; the space between being closed by an annulus or ring F of metal, on which are mounted plate angle brackets G to assist in carrying the inner shell from the outer shell. The height of the conical portion of the inner shell is somewhat greater than the height of the cylindrical portion of the outer shell; and the bottom of the conical portion carries a grate of fire-bars H arranged in a truncated conical manner. The lower end of the conical portion dips into a water seal. An opening I is formed in the cylindrical portion of the outer shell for the admission of air and steam.

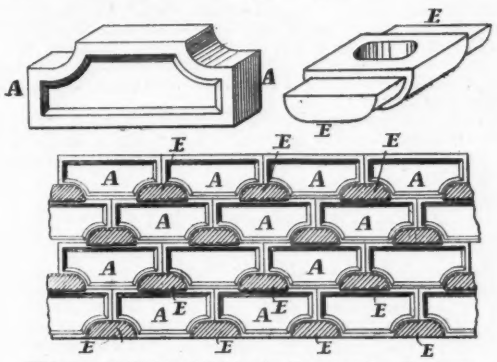
The top of the inner shell is closed by a flat plate roof, lined on the under-side with fire-brick; the corner (at the junction of the side and roof linings) being tapered as shown. The charging bell S is suspended from a large circular opening in the roof, and extends downwards approximately one-third the depth of the upper cylindrical portion, and thus lies wholly (or almost wholly) within the upper part of the inner shell. Further, the bottom end of the bell, contrary to the usual practice, is provided with a shallow converging cone T, so as to heap the load of the producer in the centre instead of up against the sides. The outlet U for the gas generated is in the side of the inner shell immediately below the roof of the producer.

Regenerative Furnace Gas and Air Passages, and Bricks Therefor.

Gibbons, G. B. A., of Lower Gornal, Stafford, and Masters, E., of Harlesden, N.W.

No. 21,643; Oct. 13, 1908.

This invention has reference to the construction of the gas and air passages of regenerative furnaces with bricks of a somewhat similar type to those described in patent No. 16,256 of 1900.



Gibbons and Masters' Bricks for Regenerative Furnaces.

The illustration shows a projected view of one of the improved bricks for forming the side walls of the gas and air passages; a projected view of one of the cross or scotch tiles for use with the bricks; and a longitudinal sectional elevation through a gas-passage formed of the bricks and cross or scotch tiles illustrated.

Instead of the lump on the bricks A being formed with right-angled rebates as in the 1900 patent, they are rounded off so that the sides of the lumps are curved or gradually inclined to the body of the brick; and the rebated end portions of the cross or scotch tiles E which fit into the gaps formed by the recessed parts in the side walls of the gas and air passages between the lumps are shaped to correspond—that is to say, they are rounded or inclined. Again, the bodies of the cross or scotch tiles E are also by preference made of corresponding shape as shown, but so much larger as to leave rebates all round, or partly round, so as to form shoulders which constitute the abutments against the faces of the bricks A forming the side walls. The rebated cross or scotch tiles may also, if desired, be lightened by each having a vertical hole formed in them, and may also, if desired, for the same purpose have a frog impressed on their faces.

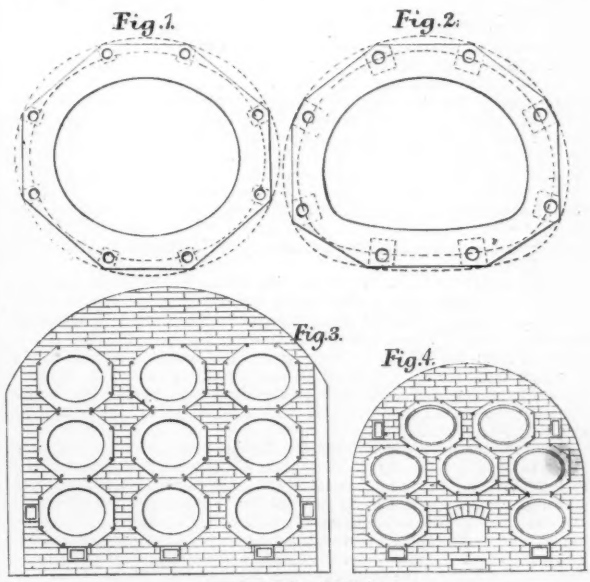
In laying these "improved bricks," it somewhat facilitates the work if the bricks are laid with the lumps at the bottom, as shown—that is, in the reverse position to that noted in the earlier patent—as by so doing when a course of cross or scotch tiles and side bricks have been laid, the top of the course is level for the next course to be laid on it.

Gas-Retorts.

Rindom, A. J. P., of Copenhagen.

No. 28,349; Dec. 29, 1908. Date claimed under International Convention July 16, 1908.

This invention relates to gas-retorts with heads or flanges of polygonal shape, with the flanges of the retorts formed octagonal, whereby they "are enabled to be placed more closely together, and thus obtain a great saving in space."



Rindom's Gas-Retorts.

In figs. 1 and 2 the usual outline of the retort-heads is shown by the dotted line; while the total width and total height of the flange

becomes smaller when it is given the octagonal shape. In fig. 3—illustrating how a retort-furnace may be built—it is seen that the retort-heads find a firm, direct bearing, partly on the horizontal courses of the end wall, and partly on top of one another. "Besides, the masonry work becomes easier to execute than is usually the case, as the end walls are largely limited by the horizontal and vertical edges of the retort-heads, and not, as usual, by their continuously curved edge. Even those parts of the brickwork adjoining the inclined edges become considerably easier to lay than brickwork adjoining a curved surface. The inclination of the sloping edges is alike throughout, and special blocks with sloping sides may therefore be used for this work. As the retorts rest on the horizontal surface of the retort-heads, all difficulties in getting them adjusted accurately in the proper position disappear, and the same applies to all temporary support during setting. As the retorts may be placed directly on top of one another, the height of the furnace is smaller than usual."

In fig. 4 is shown a retort-furnace illustrating how the retorts may be supported one on top of another, with the sloping edges of their heads in contact. "Especially in this design of furnace the saving of space is evident."

Quenching and Conveying Coke.

RIES, HANS, of Munich.

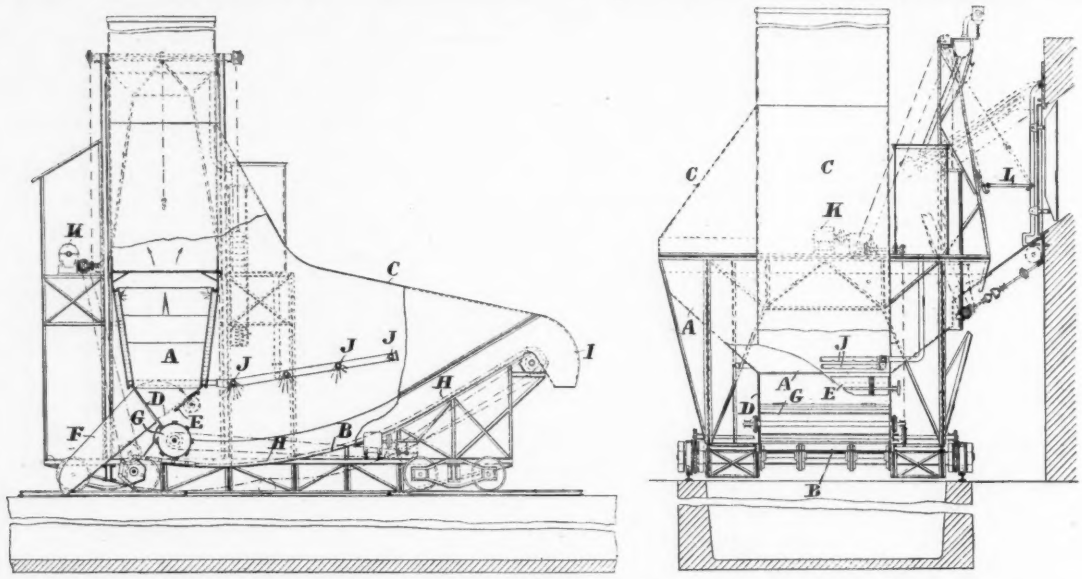
No. 3677; Feb. 15, 1909.

This invention relates to apparatus for quenching and conveying coke of the type wherein incandescent coke is discharged from the retort into a trough mounted on a traveller carrying mechanism for opening and closing the retort doors, and sprayers for the incandescent coke, which is subsequently discharged into the coke pit. The object is to provide mechanism for regulating the discharge of the partly-quenched coke from the trough, and for spreading the coke before it enters the quenching trough and as it passes thence into a quenching channel.

The frame of the traveller is supported (as shown) by bogies having wheels arranged to travel over the pit on rails. Upon the traveller is a trough A, in which the coke is partially quenched, and a channel B in which the quenching of the coke is completed as hereafter described. A shell or casing C is provided on the sides and on the top of the traveller; and the steam formed in the trough when quenching the coke escapes through the funnel above.

The width of the trough A corresponds to that of the retort, and is of rectangular shape, open at the top, and having hollow side walls adapted to contain water. The bottom of the trough is closed partly by a pivoted plate D, and partly by a slide E provided with a rack with which meshes a pinion operated by a hand-wheel to move the slide up or down and regulate the size of the opening left between the plate D and the lower edge of the slide E. By swinging the plate to the right (as indicated by dotted lines), the coke, instead of passing out from the quenching trough to the channel B, may be discharged into a shoot F, and thus reach the pit without further quenching. As a rule, however, the coke passes from the quenching trough to a distributing drum G, which extends the full width of the channel B, and is provided with projecting bars which feed the coke forwards. From the drum the coke passes to the conveyor H, which carries it upward along the inclined channel B, and finally discharges it into the pit through the outlet I.

The frame is provided with supports carrying a reservoir adapted to



Ries's Coke Quencher and Conveyor.

receive water from a stationary main with which the reservoir may be brought into register, and connected to a larger reservoir on the platform of the traveller. From the bottom of the reservoir a pipe leads downward, passing through the side wall of the traveller, and then communicating with two pipes connected with spraying pipes J extending above the channel B and adapted to spray water on the coke passing along the channel. The pipes are also connected with the jacketed wall of the quenching trough.

On the side toward the retorts the quenching trough is provided with an incline adapted to register with a shoot secured to each retort; and on the incline is provided a wedge-shaped upright blade or ridge, which serves to divide and distribute the coke as it passes from the furnace to the quenching trough—"thereby increasing the efficiency of the quenching jets." The partially quenched coke then passes out through the opening at the bottom of the trough, either directly to the shoot F or (as is more usual) to the drum G and conveyor H. In the latter case the coke is further quenched by the jets discharged from the pipes J.

The door of the retort is opened and closed by the motor K. The door swings about a pin located at its upper end, and is held in the closed position by a toothed wheel engaging a toothed rack at the lower end of the door. When it is desired to open the door, the rack is first released from the pinion by turning it by means of the worm in a direction contrary to that used in closing the door. The worm is carried by a shaft, which may be rotated by means of a clutch from a shaft carried by the traveller and driven from the motor by gearing and suitable connections.

The door carries a pivoted bracket L, the downward movement of which is limited by a stop, so that normally the bracket extends in a horizontal direction, or approximately so, as shown. The forward end of the bracket is adapted to be engaged by a hook secured to a chain so as to be raised or lowered—preferably guided in a channel. The chain passes over a sprocket, its free end being capable of being connected to the door, which it opens when the chain is wound up. By rotating in the proper direction the shaft carrying the sprocket the hook will be raised—thus pulling the door into the open position indicated by dotted lines. The coke then passes to the quenching trough over the shoot and the inclined plate. The motor K is also employed to propel the traveller.

APPLICATIONS FOR LETTERS PATENT.

13,297.—WILLOUGHBY, S., and CHAPMAN, J. M., "Dealing with the exhaust gases from internal combustion engines." June 7.
13,326.—COMINGS, W. R., "Packing mantles." June 7.
13,350.—BLAKE, E. W., "Automatically turning on and off the lights of gas-burners." June 8.
13,408.—VERSEN, B., "Gas furnaces." June 8.
13,425.—DUKE, J. F., "Automatically lighting gas." June 8.
13,428.—MASTERS, E., and HANSFORD, J., "Charging and discharging gas-retorts." June 8.
13,435.—SMITH, A., "Filling receptacles from a hopper." June 8.
13,491.—HARPER, H., "Pendants and brackets." June 9.
13,538.—OGDEN, J. E. L., "Valves or cocks." June 9.
13,540.—TUCKETT, F. S., "Tipping coal waggons." June 9.
13,549.—TULLY, C. B., "Carburetting gas." June 9.
13,593.—HARDY, H., "Indicating and regulating the temperature of gas appliances." June 10.
13,602.—WILLIAMS, J. L. H., "Power and gravity conveyors." June 10.
13,604.—SIMMONDS, H., "Manufacture of gas." June 10.
13,654.—POTTER, W. G., "Water engines." June 10.
13,673.—CHECINSKI, A. F., "Water-meters." June 10.
13,712.—FOX, H. L., "High pressure oil-gas apparatus." June 11.
13,722.—ZIMMER, G. F., and JOHNSON, A., "Combined revolving and reciprocating sifting conveyor." June 11.
13,730.—CAMPBELL, T. M., "Rollers of gravity conveyors." June 11.
13,796.—ZINDLER, A., "Manufacture of gas by the dry distillation of fuel." June 11.
13,820.—KAY, W., "Steel-cutting twist drills." June 12.
13,840.—PYNEGAR, H., jun., "Screen conveyors." June 12.

Gas and Water Appliances, Limited, is the title of a Company registered on the 14th inst., with a capital of £10,000 in £1 shares, for the purpose of acquiring the business of the Khoma Gas-Arc Lamp Company, Limited (in liquidation), as noted in the "JOURNAL" for the 8th inst.

CORRESPONDENCE.

[We are not responsible for opinions expressed by Correspondents.]

Vertical Retorts.

SIR,—Looking through British-made spectacles at a foreign name-plate, and at the same time reading of the truth being forced into consciences that have lately developed a Continental taste, seems to bring out confessions, covered by a purpose, to avoid such unpalatable proof as is to be read in the report of Mr. J. H. Brown, of Nottingham, to his Committee.

As everyone knows who has had experience with vertical retorts, the "fill and empty" system—in bulk—yields only gas of low illuminating power unless it be for (say) the first forty minutes after the charge has been introduced, when 21 or 22 candle gas is easily obtained.

The continuous system of feeding and withdrawing coke does maintain the higher candle power, producing from 50 to 60 per cent. less tar than the same coal would yield carbonized in horizontal retorts. Where and why this difference exists is to-day, at any rate, not a settled point, even among expert carbonizers.

The long time experience and work carried out at Exeter produced results just as puzzling as they were too convincing to doubt.

The moment the timely withdrawal of coke was stopped, and the charge allowed to rise in height, the illuminating power of the gas commenced to drop, while the amount of tar increased.

Ideal carbonization appears to remain in the zone-length of a retort fed from 2 to 3 feet from the bottom—occupied by hot coke—and on to a height of not more than 8 feet in all, giving also out of this a clearance of at least 1 foot above the charge at the top of the retort.

It may be worth while to give a few practical results in support of the above. Taking three classes of slack coal (from the many operated upon) with continuous feeding in short length carbonization, the following results were obtained:—

Camerton slack for	9½	hours averaged	20·18	candles.
South Pelton ,,	9½	,, ,,	20·45	,,
Newbury ,,	9½	,, ,,	20·75	,,

The make of gas averaged about 11,200 cubic feet per ton.

The above short-contact carbonization, with small-quantity feeding and timely removal of coke formed, using slack coal, was continued through longer periods as follows:—

			Candle Power.	Tar.
Six days	Hebburn	(slack) = 13,358 cubic feet per ton	13·80 =	None.
,,	Newbury	(,,) = 13,266 ,, ,,	13·60 =	,,
,,	West Levers'n	(,,) = 13,570 ,, ,,	13·50 =	,,
,,	Camerton	(,,) = 13,282 ,, ,,	13·60 =	,,
,,	Waldegrave	(,,) = 13,375 ,, ,,	13·80 =	,,
,,	South Pelton	(,,) = 13,192 ,, ,,	13·70 =	,,
,,	Radstock	(,,) = 13,260 ,, ,,	13·64 =	,,

The above, with other slack coals covering three months' tests of six days each, gave an average of 13,189 cubic feet per ton of 14·56-candle gas with no tar—more at the finish than at the commencement. The same coals carbonized in ordinary horizontal retorts yielded about 10,300 cubic feet per ton of 14·7-candle gas, with, of course, the usual quantity of tar produced.

Whatever else attends the non-decomposition of the hydrocarbons in the gas, or the complete decomposition of the tar, much remains in the rapid evolution of gas and the getting of it away as quickly as possible without subjecting it to long surface-contact with heat that it no longer really requires.

This roasting process is more than a hundred years old; and why it is such a "gum label" on carbonization is now, I am happy to see, being seriously considered and worked upon.

That short-length carbonization, small-quantity charges, with great attention to temperatures—more especially the overhead temperatures—are all conducive to the better distillation of the coal, remains, it would appear, in the analyses of the gas obtained.

The following among many are analyses taken at the commencement and finish of a charge carried out as already described:—

	A.		B.
Carbon dioxide	0·30	..	—
Oxygen	0·00	..	—
Unsaturated hydrocarbons	3·06	..	7·06
Saturated ,,	60·05	..	52·29
Carbon monoxide	4·02	..	4·02
Nitrogen	0·00	..	—
Hydrogen	32·57	..	36·63
	100 00	..	100·00

Personally, I am grateful indeed to the President of the Institution of Gas Engineers, Mr. Thomas Glover, to know by his words that I am at least associated with "the germ of continuous carbonization."

Throwleigh, near Okehampton, June 18, 1909. T. SETTLE.

The Institution Discussion on Mr. Forshaw's Paper.

SIR,—With regard to the paper read before the Institution of Gas Engineers, entitled "A Comparison between the Illuminating Efficiencies of Carbon Monoxide and Hydrogen when Used in Conjunction with the Incandescent Mantle," by Mr. Arthur Forshaw, M.Sc., I was asked previous to the meeting to prepare a few remarks. However, I was unable to speak on the matter, owing to lack of time. I think, therefore, that the gist of what I intended saying may prove of interest to gas makers from a gas-burner maker's point of view; and so I am enclosing this, hoping you will find space for it.

63, *Queen Victoria Street, E.C., June* 18, 1909. C. W. BLAND.

[ENCLOSURE.]

It was generally received among gas-burner makers that gases that are identical in calorific power would give approximately the same illuminating efficiency. It seems, however, pretty clear from the experiments made by Mr. Forshaw that the notions of the past have not the fundamental ground for their support that had been imagined—in view of the fact that, taking two pure gases such as hydrogen and carbon monoxide, having practically the same calorific power, one cannot obtain, however much the air supplies are manipulated, the same illuminating efficiencies from mantles.

Of course, in this matter, as a gas-burner manufacturer, I have to deal with gases of complex constitution, and not with single pure gases. This being so, the point in which (having in view the results of Mr. Forshaw's experiments) I am most interested is how to secure maximum efficiencies with similarly constructed burners under the variation of complexity in the constitution of gases which the gas-maker gives me to deal with. We have fully recognized in constructing our burners that, notwithstanding an approximate relationship in calorific powers in different districts, different constituents of the gas have a large effect on the illuminating efficiency obtained from the same burner; and, naturally, we have ascribed this to the differences brought about by the variation in methods of carbonization, and the use of different proportions of water gas, carburetted and otherwise.

To meet this condition of things, has been the sole reason for the introduction of both the gas regulator and the air regulator. This to an extent proves that, though gas-burner makers have not got so far as to appreciate the points that Mr. Forshaw has now brought before them, they have recognized the necessity for varying the ratios of gas and air in different districts to secure the necessary flame-temperature and flame-volume to properly incandesce and fill the mantles.

But after all is said and done, it seems to me that the lessons to be obtained from the paper were more for the gas-maker than for the gas-burner maker. If the gas-maker would give a gas of constant constitution, gas-burner manufacturers will undertake to produce a burner that will with such gas give a constant efficiency.

Purification in Closed Vessels.

SIR,—Although this desideratum of gas manufacture has not yet been attained fully, it seems to me we are within easy reach of most of the advantages that were originally claimed for such a system of gas purification. In this connection, the following experience on our own works may be of interest.

On the 6th of October last, we charged one of our purifiers with 23½ tons of special oxide of iron. The box was left in use without intermission until the 17th of May of this year. The oxide was then, for the first time since being put in new, taken out and revivified. On testing, it showed 47 per cent. of sulphur on the dry basis.

In all, 48,794,000 cubic feet of gas passed through the purifiers, which had, in fact, been doing the bulk of the purifying during five out of the seven months referred to.

I think that my experience is not quite an isolated one; and if this be the case, I hope we may be favoured with an exchange of experiences that cannot fail to be of practical interest to the industry.

Chichester, June 17, 1909. T. E. PYE, F.C.S.

Sunday Labour Question.

SIR,—I enclose a letter from Sir George Livesey, which I received just before the last circulars to gas managers were sent out (1901). It might be interesting just now, as it is the first meeting of the Institution of Gas Engineers after Sir George's decease.

A well-known engineer would have brought it before this year's meeting; but he was uncertain of being able to attend.

Sir George Livesey is best known perhaps *re* profit sharing, &c.; but the letter I enclose shows his great interest in the Sunday Labour Question.

7, *Carlton Road, Sidcup, June* 15, 1909. PETER STEEL.

[ENCLOSURE.]

Peter Steel, Esq. *Shagbrook, Reigate, Aug.* 1, 1901.

My dear Sir,—I shall be willing to bear part of the expense (say £5) of the work [sending out circulars to gas managers as to the Sunday Labour Question] you purpose doing through Mr. Shadbolt.—Yours very truly,

GEORGE LIVESEY.

A Brave Gas Coal Porter.—A coal porter at the Shoreditch Gas-Works, Thomas Jackson, aged 46, of 79, Whiston Street, Haggerston, appeared at the Bethnal Green Coroner's Court a few days ago, displaying on his breast a number of medals, and gave evidence regarding a fatal street accident he had witnessed. A man of reserved manner, he told a Press representative the story of the medals he wore. It appeared that he had saved no fewer than 99 lives. One medal he received from his fellow-workmen, in recognition of the fact that, up to May, 1893, he had rescued seventeen children from drowning in the Regent's Canal. He has been the recipient of seventeen testimonials from the Royal Humane Society.

An Object Lesson in Gas Lighting at Hyde.—The Manager of the Hyde Gas Company (Mr. C. Potts) is showing the residents what gas can do in the way of shop lighting, and is following up his object-lesson by distributing a handbill giving the cost for a week with gas and electricity. The shop is fitted up with 20 "Graetzin" incandescent gas-lamps, the lighting power of which the makers claim to be 120 candles each, equalling a total of 2400-candle power. The number of hours they are lighted during the week is 10. The gas consumed, as registered by the meter, is 1000 cubic feet, which, at 2s. 9d. less 7½ per cent. discount, amounts to about 2s. 6½d., or (say) 3d. per hour for a light of 2400-candle power. Mr. Potts says it would take 48 Tantalum incandescent electric lamps, representing, according to the makers, 50-candle power each, to give an equivalent amount of light; and as these lamps would each consume 85 watts per hour, the quantity of electricity used would be 40·8 units. This, at 3½d. per unit, would cost 11s. 11d., against 2s. 6½d.; being an extra cost of 9s. 4½d., or more than four times the cost of lighting by gas. There are many similar instances in Hyde.

PARLIAMENTARY INTELLIGENCE.

HOUSE OF COMMONS.

The following further progress has been made with Bills:—

Lords Bills read a second time and committed: Gas Orders Confirmation Bills (Nos. 1 and 2), Lisburn Urban District Council Bill, Stourbridge and District Water Board Bill.

Bills reported, with amendments: Cardiff Corporation Bill, Pontypool Gas and Water Bill [Lords].

Bills read the third time and passed: Blackwood Gas Bill, Clevedon Water Bill [Lords], Gaslight and Coke Company Bill.

THE GASLIGHT AND COKE COMPANY BILL.

Third Reading Passed.

House of Commons.—Thursday, June 17.

On the Order for the third reading of the Gaslight and Coke Company Bill, which, as our readers are aware, has been several times postponed,

Mr. W. THORNE moved that the Bill be read the third time that day three months. He said that when it was before the House two or three weeks ago, he was under the impression that there was a possibility of an agreement being arrived at between the promoters and the West Ham Corporation. It appeared that since that time there had been overtures made on one side and the other; and the result was that they stood in exactly the same position now as when the Bill was before the House on the last occasion. Hon. members who had read the clauses of the Bill would have noticed that it was sought to bring about an amalgamation between the Gaslight and Coke Company and the West Ham Gas Company; and the Bill affected a very large number of consumers both in West Ham and in the Metropolitan area. He thought the consumers supplied by the two Companies numbered something like 600,000. Personally he did not think the Bill was required, because there was absolutely no competition between the Gas Companies in London. There were really only four Companies who supplied the major part of the gas; and each had a separate area assigned to it by Statute. He did not know whether what he was going to mention would have any bearing on the question, but he wished to state that there had been no official sanction given by the stockholders of the West Ham Gas Company to the proposal in the Bill. There was a meeting held some time ago which was declared to be illegal; and a meeting to get the stockholders' sanction would not be held until the 22nd inst. Therefore there was no way of knowing whether or not the promoters were voicing the opinion of the stockholders of the West Ham Company. He was of opinion that the Bill had been practically rushed by the Gaslight and Coke Company, because it was not until Nov. 19, 1908, that a circular was sent out by the Directors or the Secretary of the West Ham Company to the stockholders. In the last paragraph, the Directors said they much regretted that they had not been able to include in the communication the terms of agreement; but they pointed out that the shortness of the time available before giving the necessary notice for the Bill had rendered this impossible. This proved to him, at any rate, that the Bill had been rushed to some extent, without getting the official sanction of the stockholders of the West Ham Company. There was no doubt that there was strong opposition to the Bill in the whole borough of West Ham. In connection with the proposal, a public meeting was held at the Stratford Town Hall towards the end of December; and, in spite of the inclement state of the weather, there was a very large attendance. A resolution was carried unanimously against the proposed amalgamation. When an amalgamation was sought by two or more companies, there were generally assurances given to the general public that they were going to be benefited. He could assure the House that, so far as this Bill was concerned, it benefited no one—whether consumer, ratepayer, or workman. No doubt the promoters of the Bill had silenced the regular opposition by the method that had been adopted. Clause 6 provided that they were going to give to the West Ham stockholders £118 for each £100 of ordinary stock; £125 for each £100 of preference stock; and the 4 per cent. debenture holders were to receive £133 6s. 8d. per £100 of stock. No doubt, therefore, the stockholders of the West Ham Company were receiving some little consideration in the price that was to be paid for their stock. The promoters had sent out a circular to the whole of the shareholders, and also to the members of the House of Commons. It was, no doubt, being sent out with the deliberate intention of frightening the shareholders of the West Ham Company, because it stated that unless the amalgamation was brought about they would have to erect new works at East Ham, at an expenditure of £250,000, which would be unproductive for some years to come. He wished to assert that there was absolutely no need at all for the Company attempting to build new works. He was perfectly certain that if it were possible for the members of the House to pay a visit to the West Ham Gas-Works, they would be able to see that the Company had sufficient ground to erect another retort-house and to extend one of the present houses. In his judgment, they had sufficient capacity at these works to supply for the next 25 years the whole of the consumers comprised in their area. So far as the gasholders were concerned, he would admit that they would have to erect another holder; but this would not cost more than £60,000 at the outside. The promoters had adopted another artful way of buying up the opposition to the Bill. They had promised the London County Council to reduce the price of gas 1d. per 1000 cubic feet; but the reason why the promoters had agreed to do this was because in one of the clauses of the Bill they were going to reduce their illuminating power from 16 to 14 candles, and they would save a very large sum of money by this method. When the South Metropolitan, Commercial, and West Ham Gas Companies applied for authority to reduce the illuminating power of their gas from 16 to 14 candles, they agreed to reduce the price 2d. Again, they had bought out the opposition from the Lambeth Borough Council, who had instructed their Town Clerk to petition against the Bill unless certain concessions were made. One of the concessions asked for was that the price of gas by this particular Company on the south side of the Thames should be reduced 2d. per 1000 cubic feet. The result was that they had agreed to this. If it were possible for the promoters to reduce the price of the gas 2d. on the south side of the Thames in consequence of lowering the illuminating power from 16 to 14 candles, why was it not possible to supply all the Metropolitan area at this reduction? He supposed they thought they would be making too great a concession if they did so. Then they had bought out the opposition of the East Ham Borough Council by erecting a bridge in a certain part of the borough which had been absolutely essential for some time past. So they had "squared" the shareholders, the London County Council, the Lambeth Borough Council, and the East Ham Borough Council; the only people they had not "squared" being the West Ham Corporation. As a matter of fact, he thought what was asked for by the Corporation was only a very fair and reasonable concession. He did not know whether members of the House recognized what it meant to reduce the illuminating power of gas from 16 to 14 candles. As a matter of fact, if it had not been for the introduction of the incandescent mantle, it was very questionable whether the House or anyone else would have given any company permission to reduce the standard. When they came to lower the illuminating power from 16 to 14 candles, particularly in some of the small tenements where it was impossible for the tenants to supply themselves with incandescent gas-mantles in consequence of the expense, the result would be that a great number of the small consumers who had gas on the penny-in-the-slot system would suffer considerably. He also wished to say that, so far as West Ham was concerned, the consumers were receiving absolutely no consideration at all; they would indeed be "worsened." The standard price of gas at the present time, as far as the Gaslight Company were concerned, was 3s. 2d.; and the standard of the West Ham Company was 2s. 11d. The selling price of the gas under the Gaslight and Coke Company was 2s. 9d. per 1000 cubic feet; it was 2s. 8d. under the West Ham Gas Company. Therefore this proved to him that when the amalgamation had been brought about the Company could increase the price of gas from 2s. 9d. to 2s. 11d., without interfering with their present dividends. Of course, he knew that this was what was known as the sliding-scale, which regulated the selling price of gas and the dividends paid to the shareholders; and he did not say for a single moment that it would be to the interests of the Company to increase the price. He supposed they did their level-best to keep it down as far as they possibly could. But when Bills of this kind were promoted, when there was an amalgamation sought by two or more companies, it was generally understood that no one was going to be worsted. He wished to point out to members of the House that, so far as the workmen were concerned, those of the West Ham Company would be worsted, because they had in operation a pension scheme by which, after serving the Company for 25 years, they had one-third of their maximum pay. Of course, he would have to admit that the Gaslight Company had a kind of superannuation scheme, and there was a recognized understanding, which he admitted had become a custom, that when a man had worked for a certain number of years he was pensioned off with a certain amount; but then the men were working on sufferance. They had no guarantee that they were going to receive a pension at all; but the West Ham Company were practically under a statutory obligation to pay the men in accordance with the number of years they had worked. There was no doubt, therefore, the men working for the West Ham Company would be worsted by the Bill. One of the chief clauses was the 30th, under which the promoters agreed to keep open the works at their present capacity; but after ten years there was no guarantee that they were going to keep them open at all. In fact, he knew coal could be carbonized at the Beckton Gas-Works very much more cheaply than at the West Ham works. This was a very serious thing to the people in West Ham. Most of the members of the House knew that the borough was a very poor one; and, in consequence of the large shipyard being cut out from building any of the war vessels now, thousands of men had been thrown out of employment. If the gas-works were shut down, as he believed they would be after ten years, it meant that the bulk of the men would be put upon the scrap heap. A number, no doubt, would be transferred from West Ham to Beckton; but the major part of the men would not be able to find any employment at all. He was aware that if the works were shut down, and a certain number of men were not required, then, by mutual arrangement between the men and the Company, certain compensation would be provided; and if the men were not satisfied, he believed it was set forth in one of the clauses of the Bill that they could appeal to an arbitrator. Most of them knew that for ordinary workmen, who had been receiving weekly wages and keeping themselves from hand to mouth for a number of years, it would be utterly impossible to find the wherewithal to fight a rich company like the Gaslight and Coke Company. Moreover, by the closing of the works their rateable value would be depreciated by 50 per cent.; and this meant that the ratepayers would have to raise a few more thousands of pounds in other directions. The Company were also going to shut down another of their works in the borough; but, of course, the Local Authority had no control over them. At the same time, it meant that a number of men would be thrown out of employment. He trusted the House would not give a third reading to the Bill, because, as he had pointed out, workmen would be affected and the rateable value of the borough would be depreciated. The consumers of West Ham were not going to receive any benefit, nor were the ratepayers or the workmen. In view of the facts he had stated, he could not see why the House should pass a Bill of this kind, which apparently was only in the interests of the shareholders and the Directors of the two Companies concerned. Upon these grounds, he moved the rejection of the Bill.

Mr. P. F. CURRAN, in seconding the amendment, desired at the outset to make it perfectly clear that he and his honourable friend were not taking this line of action out of any spite or hatred towards the Gaslight and Coke Company. He did not know the technical details as to how the proposal in the Bill would apply to West Ham so well as

his friend did. But he had been a resident there for more than twenty years, and had had an official association with Trade Unionists who earned their living in connection with the production of gas. At the town's meeting which was held, there were present representatives of all sections of the citizens—business people, workpeople, and a number of members of the Corporation. Though the gathering was essentially of a mixed character, yet the resolution which was submitted against the adoption of the Bill was passed unanimously. In his judgment, this was a strong argument against the Bill. West Ham was not at present governed by Labour representatives—in the borough they were in a minority; yet business people and other men who were considered to have municipal and political views of a moderate character were as bitter in their opposition to the Bill as any other section of the West Ham population. When they found that the representative people—the consumers and especially the workpeople, even those who were employed in the local gas-works—were unanimously against this proposal, he thought the House would concede that it was an opposition of a kind which ought to carry weight. Why were the people of West Ham opposed to the Bill? Those of them who knew anything of municipal as well as parliamentary affairs were aware that it was not always to the interest of the public in general, and the working-classes in particular, that the big fish should come along and swallow the small fish. Yet this was exactly what was taking place in the case of this particular Bill. It was the matter of a great Company who had a practical monopoly of the supply of gas for a large part of London coming to a small Company who supplied a borough, and making with them terms whereby they might be enabled to rush their Bill through the House with as little opposition as they could possibly manage. He did not think that the House should lend itself to any scheme whereby a great company would have some little advantage over a small one, while it would at the same time take advantage of the public in general. In his judgment, the people of West Ham would very much prefer to see the gas supply in the hands of the Corporation—if not at present, at any rate at some future time. It was because of their desire to see the supply come under municipal control that they were largely opposed to the Gaslight and Coke Company taking over the West Ham Company now. He hoped the members who represented various interests in the House would take into consideration the all-important point that it was not only a working-class and a consumers' opposition, but that the commercial people in the whole of West Ham were as much against the Bill as the men in the gas-works. He would undertake to say that not one member of the House had been approached by a representative of the West Ham Company, or by an authorized agent of the Company, to support the third reading of the Bill; and he submitted that the legislative powers conferred on the House should not be utilized for the purpose of going against the express desire of every section of the community in a particular locality, when it was against a Bill. Under these circumstances, they were deadly opposed to the third reading, not only from the Trade Union or working-class point of view, but also in the interests of local employers and other interests, vested and otherwise, opposed to the Bill.

Sir DANIEL F. GODDARD thought the honourable members who had moved the rejection of the Bill had, probably quite unintentionally, misled the House as to its character. In making the statement that there was a "rushing" of the Bill through the House, they altogether forgot the fact that it had been submitted to a very critical examination, and that the Corporation of West Ham had ample opportunity of stating their case before the Committee who considered the Bill. He thought this very materially altered the position. The honourable member who moved the rejection of the Bill seemed to have a complaint that the other parties had been wise enough to settle while the West Ham Corporation were not so wise. The Corporation had, he was told, every opportunity of settling before the Bill went into Committee, but they absolutely refused to come to terms; and surely it was a little late, at this stage of the proceedings, to ask the House to reject the Bill on its third reading, because they had not been wise enough to take advantage of the opportunities offered to them.

Mr. THORNE: As a matter of fact, it is the Gaslight and Coke Company who have gone behind what they promised to the West Ham Corporation.

Sir DANIEL GODDARD said he was informed that this was wrong. They were offered terms before the Bill went to the Committee, without prejudice to either side. The terms were rejected; and it would not be fair, in any business transaction, to bring this out and say it was a breach of faith on the part of those who made the offer. A great deal had been said about a public meeting held at West Ham against the Bill. If there was this strong feeling against it, why was it not opposed when it came up for second reading? That was the time, instead of giving the parties all the trouble and expense of going through the course that had been taken. There was no opposition whatever to the second reading; and it was only now, when the whole matter had been most carefully sifted by the Committee, that opposition was offered, and hon. members moved the rejection of the Bill. On behalf of the promoters, he must protest that there was no warranty for the suggestion that the Bill had been "rushed" through the House.

Mr. THORNE: I did not say it had been rushed through the House. I said the Gaslight Company had rushed the Bill.

Sir DANIEL GODDARD said the implication was the same. It had been put off from time to time, and there had really been no rushing. He did not think the hon. member could substantiate that statement in the slightest degree. The hon. member said that no one was advantaged by the Bill. As he (the speaker) understood it, the Gaslight and Coke Company were willing, when they took over these works, to consider all the payments of the workmen of the West Ham Company in regard to their pension scheme, or any other scheme, as if they had been made under the Gaslight and Coke Company. Surely more generous consideration could not have been given to the workmen. He believed the schemes of benefit of the workmen of the Gaslight Company were much more advantageous than those of the West Ham Company. The hon. member had referred to clause 30 of the Bill as one of the objectionable clauses. This clause, however, seemed to him to be one of its greatest commendations. It was a very unusual clause, displaying most unwonted generosity on the part of the promoters of such a scheme as this. It absolutely stated that the Gaslight Company, in taking over the West Ham Company, were willing to give a guarantee that for ten years they would keep the works in substantially the same condition as now, whether the use of gas went down or anything else happened. He was, therefore, rather surprised to hear the statement made by the hon. member, because he would have deemed this to be most generous treatment both of the workmen and of the ratepayers. The hon. member had also ventured into the region of prophecy, which was always somewhat dangerous. He said he had no doubt that when the ten years had expired, the West Ham Gas-Works would be shut up. He (Sir Daniel) did not think that the hon. member had any real reason for this statement. The Gaslight Company had absorbed many other gas undertakings in the Metropolitan area; and he believed that out of all those they had acquired, only two of the works had been entirely closed, though they were taken over without the safeguard contained in clause 30 of this Bill. Therefore he did not think there was much to be said against the Company on the score of clause 30. It was a very generous concession, and to say that the ratepayers obtained no benefit seemed to him a most absurd line of argument. The hon. member also stated that the works could be kept going, and that the ratepayers would have the benefit of their being carried on in their area. He was advised that it was proved distinctly before the Select Committee that this was not so. He was told that the total daily productive power of the West Ham works was 9,100,000 cubic feet, and that the actual average output for the three heaviest consecutive days in the year 1908-9 was 8,091,000 cubic feet; leaving only a margin of 1,000,000 cubic feet, or 13 per cent. When they remembered that the average increase in the gas supplied during the past five years had been 9 per cent., he thought it would be seen that the works could not possibly have continued for more than two years at the outside, and would then have had to be removed.

Mr. THORNE: The Company have sufficient room to build two more retort-houses, which would increase the capacity by 25 per cent.

Sir DANIEL GODDARD said he was dealing only with questions which were thoroughly proved before the Committee. He could not go behind these, and take what the hon. member considered might be done. The probabilities were that the West Ham Company, if not absorbed by the Gaslight Company, would remove their works to East Ham. If they wanted to build modern works, they would do it very much better there. They had bought land there, and had already expended money in the erection of a gasholder upon it; and it was stated before the Committee that they were prepared to lay out a quarter-of-a-million in the erection of new works at East Ham. What would have been the effect on the ratepayers of West Ham if they had done this? The House must see that in this case they would have lost all the rating on the works. So that the ratepayers would distinctly benefit by the proposed transfer, inasmuch as they had a guarantee that the works would be kept in substantially their present condition for ten years to come. Then there was another advantage which he thought had been quite overlooked by those who opposed the Bill. He was told that the London local authorities would benefit to the extent of £8000 per annum in the matter of public lighting—this was equivalent to 2d. per 1000 cubic feet—and that the authorities, including West Ham, whose area the amalgamation would affect, would benefit to the extent of £1300 per annum, or 4½d. per 1000 cubic feet. Thus there was a direct benefit arising to the public in the matter of public lighting, even if there was no immediate benefit in the price of gas. The hon. member made a great deal of the point that the illuminating standard of the gas had been reduced from 16 to 14 candles. He must know quite well that all legislation had gone in the direction of lowering the illuminating power, because the system of lighting had been completely revolutionized by the use of incandescent mantles. When they wanted to get illuminating power from these, it was not the light-giving but the calorific power of the gas that had to be considered; and the Bill contained conditions as to tests for calorific value, which was a far more important thing, under the present conditions of gas lighting, than illuminating power. Therefore it was really making a mountain out of a molehill to talk of this reduction from 16 to 14 candles as an injury to the people concerned. He was very glad to know from the speech of the hon. member for Jarrow (Mr. Curran) that there had been no "lobbying" in connection with the Bill. If there was one thing to be detested, it was the kind of lobbying which the hon. member said had been absent on this occasion; and at this they must all rejoice. He (the speaker) did not think any case had been made out against the third reading of the Bill. The measure had been thoroughly considered by the Select Committee, who, he believed, were unanimous in passing the preamble. They inserted in the Bill certain provisions which had been beneficial, and would be to the advantage of the neighbourhood concerned; and he hoped, on these considerations, the House would agree to read it a third time.

Mr. J. J. MOONEY explained that he rose only on account of the fact that he was a member of the Committee who considered the Bill. If the facts, as the hon. member who moved the rejection of the Bill presented them, had been accurate, he would not have liked to have been a member of the Committee who passed the Bill. Without reflecting on the hon. member in any way, he might say that the facts, as he had presented them to the House, were quite different from those that were presented to the Committee. It was proved to the satisfaction of the Committee that the shareholders of both the Companies had been consulted, and had agreed to the Bill. It was not right to come down to the House and make *ex parte* statements to the effect that the shareholders had not been consulted.

Mr. THORNE: I did not say that. I said they had not got the official sanction.

Mr. MOONEY said he understood him to say that the shareholders did not agree to the Bill. He (the speaker) said that they had agreed. The next statement made was that power had been given to the Company to reduce their candle power, without any benefit accruing to the consumer. Mr. Thorne rather gave the House to understand that West Ham was going to suffer by the diminution of the candle power in its lighting standard; but surely he knew that what had been done was to reduce the illuminating power over the whole area of the Company from 18 to 16 candles. West Ham had a 14-candle power standard, and was, therefore, not in any worse position than before.

It had been proved over and over again to Parliament that the tendency of modern times among gas companies was to reduce the illuminating power, for reasons stated by the hon. member opposite (Sir Daniel Goddard). They were placed in rather a difficulty in Bills of this kind, because it was very easy to come down to the House and make *ex parte* statements in opposition. But the Committee went into all the facts; and in this case they had found them proved to their satisfaction. He was glad to say that this particular Bill was dealt with by a Committee representing every party in the House; and they were absolutely unanimous in the decision they gave. They had it proved to them that the position of the workmen employed by the West Ham Company would not be made worse, but better, under the Bill. It was proved to them that the Gaslight Company had a very good pension scheme; and under the clause put in for the workmen taken over, they would come into this. West Ham was represented in the Committee-room by Counsel; and the Committee tried to see how they could improve the position of affairs in West Ham. As to the fact that the question of unemployment in West Ham was a serious one, they asked West Ham to help them to find a way out of the difficulty. West Ham's representative came before them and made a statement to this effect: "I tell you frankly it will satisfy me if the Company will undertake that, for the next ten years, they will not close the West Ham works, but that they shall be substantially used for the manufacture of gas. If they do this, it will meet my objection. If they do not agree, I object to the Bill *in toto*." The Committee said they were not aware of any direction of this sort having been given to any local authority or any gas company; but they carefully considered the position of West Ham. They went out of their way to insert a clause in the Bill which, in his opinion, had never been put into a Bill of this kind—to safeguard West Ham. He did think, after the Committee had given time, trouble, and attention to a Bill like this, that, having arrived at a decision on the evidence—the facts—it would be a very strong course for the House to take now to reverse the decision on an *ex parte* statement. The House had the power; but he thought they would do well to hesitate. It was proved to them that the reduction of the candle power was a reduction all round. It was proved that the workmen employed by the West Ham Gas Company would not be any worse, but better, off. It was proved to them that at present the West Ham works were running at their utmost capacity, and that, with the increase that had been going on for the past five years, it was only a question of a very short time before a large capital expenditure would be necessary to meet the increased consumption. The Committee came to the conclusion, taking all these considerations into account, that the amalgamation scheme of the Gaslight and Coke Company was one to be recommended. He did think the House would be very ill-advised, after this consideration, if they agreed with the motion of the member for West Ham.

Mr. A. C. Morton declared that he found that all the Local Authorities concerned in the matter had agreed to the Bill. He was quite aware, and he was very glad, that the Bill applied to something more than merely West Ham. It applied to a very large part of London. It could not be said that the measure was rushed, because the Local Authorities—and he was speaking for a Local Authority, the Corporation of the City of London—appeared before the Committee who had the Bill in hand. They had taken Counsel's opinion and expert advice, and had done everything that they could to sift the matter; and, as he understood it, the Corporation of London, and every other Local Authority concerned, had withdrawn their opposition, because they had obtained the amendments they asked for, as they did in the City of London. He was rather glad than otherwise that the candle power should be reduced. As a matter of fact, with incandescent mantles 14-candle power gas was just as good as 16-candle gas; and as they obtained it for less, that was so much to the good. Although no doubt in years gone by the Gaslight and Coke Company were in rather a sleepy condition, the competition of electric light and other competition had wakened them up to act more for the people than before. He was glad to know that the Company were about to complete, or had completed, a scheme whereby they were going in the future to do what the South Metropolitan Gas Company had done—that was, to share their profits with their workmen. He trusted that they would carry out the scheme as well as the other gas companies had done. He hoped his hon. friend would withdraw his resolution, because, under the circumstances, all the Local Authorities concerned had come to an agreement on the matter, and it was hardly fair to oppose the Company any further.

On the question being put, Mr. Thorne challenged a division, upon which the amendment was rejected by 203 to 43; and the Bill was then read the third time, and passed.

FERMOY GAS PROVISIONAL ORDER.

House of Commons Committee.—Wednesday, June 16.

(*Before Mr.* Mooney, *Chairman, Mr.* Gibb, *Mr.* Barran, *and Mr.* Brunner.)

This is an Order for the purpose of confirming the Provisional Order granted by the Board of Trade under the Gas and Water Works Facilities Act, 1870.

The promoters were represented by Mr. C. C. Hutchinson and Mr. W. Szlumper; Mr. Vesey Knox, K.C., appeared for the Fermoy Urban District Council.

Mr. Hutchinson, in opening the case, said the promoters of the Order were gas undertakers in certain districts in the county of Cork, one of which was Fermoy. The primary object of the Order was to endow the Gas Company with statutory powers. The capital of the Company was fixed at £14,000, of which £8000 were ordinary and £1500 preference shares; and there was additional capital of £5000. Other provisions were the standard price, subject to which the sliding-scale was applicable, and which was 5s. per 1000 cubic feet. The area of supply was 340 acres; and according to the last census the population was about 6200 persons, of whom 320 were consumers. The output was a variable quantity, having been as low as 6¼ million cubic feet and as high as 15 millions. If the conditions under which the promoters had had to work had not been adverse, the output would have been very much larger. In 1851, the town of Fermoy belonged to Sir Robert Abercromby, who approached the Town Commissioners with regard to the provision of a supply of gas. The predecessors of the Council passed a resolution giving his Agents permission to lay down gas-pipes for lighting purposes; and, later on, the Agents were empowered to enter into the contracts necessary for lighting the town, and all the powers given by Act of Parliament were vested in them. Sir Robert provided the land which was necessary for the purpose of constructing the works, under a lease of 999 years. The works were erected and successfully carried on by a small Company. In 1868, the Company passed into the hands of Mr. George Anderson and Mr. R. H. Jones, and subsequently to Mr. George Anderson alone. In 1900, he handed the undertaking over to his son, Mr. Robert Bruce Anderson, as a gift. Prior to this time, things did not work so harmoniously with the Local Authority as in earlier days; and there were little disputes with regard to the payment of accounts. In 1884, the governing body decided that they would do without gas in the streets, and told the Company to remove their pipes and standards. This took time; and the Local Authority set men to work with sledge-hammers to disconnect the pipes by driving the upstanding pipes underground. They were fractured, and serious leakages occurred, and the town was kept in darkness. Payment was asked for the damage which had been done. It took several years to discuss who should pay; but a compromise was effected. Being a non-statutory undertaking, the Company had no authority by which they could lawfully open the roads, and on each occasion it was necessary to apply to the Local Authority. Permission had previously been given; but when some of these little circumstances occurred, the Local Authority refused to permit the Company to have access to their mains under the roads. The Company then endeavoured to get access privately; but the consequence was prosecution after prosecution, and small fines were paid. There was a large school in Fermoy; and as a consequence of the leakage of gas, the Medical Officer of Health reported that there was danger to the health and safety of the inhabitants and the children. The Company agreed to put the matter right; but the Local Authority refused permission. Then the Company dug down to the pipes; but the representatives of law and order tried to eject them by force. When this failed, they turned a hose on and filled the trench with water. The result was that the lower part of the main became choked with water, and for fourteen months the town was without a gas supply at all. During the whole of this time no complaint was made that the works were not properly managed, and there was no desire expressed by the Local Authority to purchase the works, as they could have done by agreement. There was an explosion in another part of the town due to leakage; and the Company's men were forcibly prevented from effecting the repairs which were absolutely necessary. The gas supply had been withdrawn from the whole town ever since. In 1904, Mr. Anderson formed a Company, and endeavoured to agree with the Local Authority upon the terms of an Order which would give him the necessary statutory powers; but they refused to agree to any Order at all. Dealing with the Council's petition, Counsel said it was news to him that it was the practice of Parliament to fix the capital at a sum equal to the total cash paid by Mr. George Anderson and the capital expenditure the Company could prove. The petitioners contended that the standard price should be 3s. 9d. The principle upon which Parliament acted when a non-statutory company came before them was that, under certain conditions, the local authority should have the right to take the undertaking into their own hands. But, under the circumstances he had related, the conditions were such that this practice ought not to obtain. There had been no complaint against the manner in which the works had been conducted. Under the Public Health Act, the Local Authority could at any time have purchased the undertaking by agreement, had they wished. Instead, they had adopted the course of trying to drive the concern to the point of bankruptcy, and then, at a favourable opportunity, to endeavour to purchase on the present basis, when it was yielding an inadequate profit as a result of their own behaviour.

Mr. *R. B. Anderson* then gave evidence. He stated that the undertaking was handed to him by his father. When he took possession, he introduced improvements and considerably developed the concern. In 1902, the Local Authority passed a resolution that in future he would have to pay a rent of £60 per annum for the right of opening the roads. However, they made no attempt to insist, by legal proceedings, upon the payment. He had some difficulty with the Council in regard to certain payments, and, ultimately, he had to take proceedings. When the undertaking was incorporated in 1904, he took all the ordinary shares. The structural value of the plant worked out at £1000 per million. The output last year was 11¼ million cubic feet, and in the last two years had increased 40 per cent.

Mr. Vesey Knox at this stage told the Committee that the Council had twice been refused inspection of the Company's books, and asked that they should be allowed to see them before the Committee met on the following day.

Mr. Hutchinson said that, from the point of view of these proceedings, it had nothing to do with the matters to be dealt with, and, moreover, the Council were not entitled to see the books. But if the Committee thought his learned friend should see any of them, they would be produced, if possible. The Council had asked for a purchase clause. They wanted to buy the undertaking as cheaply as possible, and it was not fair that they should get information in this way.

Mr. Vesey Knox: If we can get a reasonable capital, a reasonable standard price, and a reasonable dividend fixed, we would really sooner not buy. Our object is to get cheap gas, and all we want from the books is such information as will show what has been paid by the undertakers, in order to fix the original capital. The books will be examined by an accountant and not by members of the Council.

The Committee decided that Mr. Knox should have the books.

Witness, continuing his evidence, said he put down £10,000 as the purchase price for the entire undertaking. At present, there were 8000 ordinary shares, 1500 preference shares, and £2000 debenture stock. The output had been 15 million cubic feet per annum; the

highest in any one day being 64,000 cubic feet. This could be continued quite easily, representing a make of about 14 or 15 millions per annum. They had paid a dividend of 12 per cent. on the ordinary shares; but, on an average, the dividend had been 7 per cent. When they were before the Board of Trade, the candle power was altered from 12 to 14. Last year, the price charged for gas was 5s. 2½d. per 1000 cubic feet; but on account of the higher price of coal, it rose to 5s. 10d. They asked the Board of Trade to adopt a standard price of 5s. 9d.; but it was altered in the Order to 5s., which he considered to be too low. If his hopes were fulfilled, and they reached a maximum of 15 millions, they would have to come to Parliament again for fresh capital. As a rule Irish gas undertakings required a larger capital expenditure than English ones.

Thursday, June 17.

When the Committee met this morning,

Mr. *Anderson* continued his evidence. He said it would be impossible to sell gas at 3s. 9d. per 1000 cubic feet, as was suggested in the Council's petition. The Company had frequently tried to come to terms with the Council with regard to the price which should be charged. The total expenditure in respect of the undertaking was £10,000. When, in 1868, the make of gas was 4½ million cubic feet, the undertaking was purchased for £5000. With regard to the information required by the Council, they had given them all and more than they had asked for. The works had not only been maintained in their original condition, but improved.

In cross-examination by Mr. VESEY KNOX, witness said that in 1886, the then Company was wound up compulsorily, and was purchased by his father, lock, stock, and barrel, for £3000. He did not agree that, when the matter was before the Board of Trade, he stated that they spent £4000 of capital between 1889 and 1904. The total expenditure shown on the books was £1700 odd, which included items entered as renewals.

Mr. HUTCHINSON: And the whole of this was covered by sums drawn from the profits of the undertaking?

Witness: Not necessarily. I do not know how you associate the two sums of money. We took money from our private accounts and placed it to capital when necessary. When it was not necessary, we took sums out. He went on to say that the profits of the undertaking had been as follows: In the year 1889, profit, £185; 1890, profit, £67; 1891, loss £61; 1892, loss £62; 1893, profit £62; 1894, profit £138; 1895, profit £127; 1896, profit £62; 1897, profit £44; 1898, profit £47; 1899, profit £99; 1900, profit £85; 1901, profit £72; 1902, profit £1; 1903, profit £189; and 1904, profit £571. These figures would be in addition to 5 per cent. on the investment of £3000, and improved from year to year as the capital was expended. Immediately after 1904, he began to get the benefit of the capital. It was in that year that he sold the business to a Company, which meant that he was selling it to himself—he was the Company. The purchase price was fixed at £10,000, including everything. He did not admit that £3475 had been put down as goodwill. The whole of the expenditure since the formation of the Company had been met from sources other than the £3000 ordinary capital. The Company was started with £8000 ordinary capital and £2000 debentures, all of which were paid over to him. As against this, there were certain outstanding debts, which he valued at £1500; so that he got £8500 for the structural debts. Anything that had been spent since was accounted for by the issue of preference shares or the diminution of working capital, or overdrafts from the bank. In 1905, the sale of gas was something over 13 million cubic feet, of which more than 6 millions were supplied to the War Department, who were supplied at 3s. 1d. The Company had now lost this contract; but they found it only paid expenses with a little profit. For a works making 10 million cubic feet, the cost would be 3s. 5d. The leakage had been very large; and they had been selling only 8000 feet per ton. The total supply to the town had been 6½ millions.

Mr. VESEY KNOX: You are asking a capital of £11,500 on a sale of 6 millions?

Witness: On a reduced sale of 6 millions.

And that is £1750 per million feet?—Yes.

I put it to you that there is only one statutory company in the whole of Ireland which has a capital of over £1000 per million feet of gas sold, with the exception of Queenstown, which is your own?—There are hardly any statutory undertakings in Ireland which can be compared with Fermoy.

Replying to further questions, witness said he did not press upon the Urban District Council the desirability of their buying the undertaking at an arbitration price on five or six different occasions. The object of this fight was to get a good price. There was considerable discussion as to the price of gas and the capital; but the consumers were not dissatisfied with the price charged.

In re-examination by Mr. SZLUMPER, witness said it would be impossible for the Company to sell gas at the price suggested by the Council. He had charged nothing for engineering expenses; his profit came out of the dividends of the undertaking. The most he had drawn out of the undertaking had been 5 per cent. upon the capital. As to output, he said the works were capable of producing 15 million cubic feet; but the largest amount supplied in any one year in the town (apart from the barracks) was 7½ millions.

Mr. *H. E. Jones* was then called. He said the works could put out over 14 million feet, and they had actually produced and delivered over 11 millions. He regarded £11,000 of capital as not exorbitant. Slot-meter installations required a different sort of capital altogether. There should be a minimum of £300 and a maximum of £500. Of the 320 consumers at Fermoy, 138 were slot consumers. He valued the works at £10,254. Taking into account all the justifiable capital expenditure, the situation of the works, and the cost of production, 5s. per 1000 cubic feet was a moderate price to charge.

Mr. VESEY KNOX: Can you tell me of any case where a promoter, having purchased works from a liquidator at a bargain price, has been allowed to take the goodwill value as part of the original capital?

Witness: No.

In further reply to Mr. VESEY KNOX, witness said that his structural valuation was what it would cost to provide these works in good condition; and undoubtedly the Company's works were in good condition. He did not think that, after Mr. Anderson had put all his skill and energy into the works, they should be handed over to the town. He was charging nothing for his skill and services. During the last year of the Company's working, the Council were having gas for public lighting at 5s. per 1000 feet.

Mr. *Geo. W. Anderson*, the Engineer of the Fermoy Gas-Works, gave his valuation of the works as £9898, after making a deduction for depreciation. In order to extend the works so as to be capable of dealing with 50 million cubic feet of gas, it would be necessary to spend £300, together with an allowance for extensions of mains.

Evidence was then tendered on the petition of the District Council.

Mr. *E. H. Stevenson* was called. He said that the land on which a value of £500 had been placed was worth very little. A small amount of capital expenditure would be required for some years to come. The buildings were substantial; but one of the gasholders was in a bad state. Generally, however, the works were in good condition. His valuation of the works was about £8000; and his valuation of the work which had been done since 1889 was £3000 odd. The additional capital asked for was excessive. The proposed original capital was £11,500; whereas the sale of gas in the town itself was 6½ million cubic feet, which was about £1750 per million. This was not a fair figure for capital expenditure in the town, although, of course, some of the capital had been expended upon the War Department. The way in which the standard price had been fixed had always been, upon opposition, with reference to what the gas could be supplied at. It was sometimes an excuse, in the small towns of Ireland, that coal was dearer than in England; but that was not true when speaking of places which were near a railway. A fair standard price would be 4s. per 1000 cubic feet; 5s. was very excessive. The working expenses and maintenance ought not to amount to more than 1s. 6d. per 1000 cubic feet. It was the practice of Parliament to put in a purchase clause where a non-statutory company was coming for statutory power. If the standard price were lower, it would result in an immediate profit to the undertaking. He disagreed with Mr. Jones, and held that the works were badly managed.

Friday, June 18.

Mr. *Stevenson*, in further cross-examination this morning by Mr. SZLUMPER, said that the Company should sell 6½ million cubic feet of gas for £650; and they ought to make 10,000 cubic feet of gas per ton of Durham coal. It was well known that between 11,000 and 12,000 cubic feet had been produced from Durham coal of 14 or 15 candles, and using the No. 2 "Metropolitan" burner. His valuation of the works at Fermoy was approximately £8000; but he had allowed nothing for depreciation. Mr. Jones's valuation was, in his opinion, £2000 too high. The capital asked for was excessive—£4000 would be ample. There were people who might be served with gas; but when he visited the place, he was told the gas was bad. If the Council obtained what they asked for, they did not desire a purchase clause. But if the Committee considered the prices charged to be fair, they would not be satisfied. They would ask for a purchase clause.

In re-examination by Mr. VESEY KNOX, witness said there ought to be more gas sold in Fermoy; but it would not reach the amount stated by the promoters. The Board of Trade returns indicated that in small towns in Ireland gas was enormously dear. With proper management gas could be sold in Fermoy for 4s. per 1000 cubic feet, and could be made for less than 2s. 6d. The Local Authority did not wish to burden the rates with the risk of the undertaking if they could get gas at 4s.

Mr. *C. F. Spencer*, an accountant, said the total capital expenditure from 1889 to 1904 amounted to £1759, including certain items for renewals which ought not to have been charged to capital. Since March, 1908, the expenditure had been £1817. The average selling prices in Fermoy had been: In 1905, 4s. 2·11d.; 1906, 4s. 2·70d.; 1907, 4s. 0·48d.; and 1908, 4s. 0·85d.

Mr. VESEY KNOX, addressing the Committee on behalf of the Urban District Council, held that when the Company were charging the consumers generally a price of about 6s., while the consumers knew that the price in neighbouring towns was about 4s. and the price charged to the War Department was only about 3s., there was cause for friction. The Company for years tried to drive a bargain with the Council, and promised to come to Parliament for statutory rights; but so long as the District Council retained their right to question the amount of the original capital and standard price, they neglected to do so. With regard to the standard price, he contended that the fact that the Company had been able to supply the War Department at 3s. 1d. indicated the price at which they could make the gas.

Mr. HUTCHINSON pointed out that the whole matter had been very fully considered by the Board of Trade; and the Provisional Orders issued by them were handled with particular care. The Board decided equally between the parties, and had accepted the voluntary offer of the promoters to reduce the ordinary dividend of 10 per cent., as authorized by the Gas-Works Clauses Act, to 8 per cent. The contention of the District Council was that if the price to be charged for gas was fixed so low that there was little probability of a profit, they did not want to purchase; but if the price promised a profit, then they asked for a purchase clause.

The Committee confirmed the Provisional Order; but altered the price to 4s.; the original capital to be £8000; the additional capital, £3500; and the dividend on the whole of the capital, 7 per cent.

Mr. SZLUMPER asked for time to consider whether the promoters would take the Order. Eventually, however, they decided to do so.

Basford Water Supply.—At the meeting of the Basford District Council last Tuesday, it was mentioned that a letter had been received from the Local Government Board intimating that authority had been given for the borrowing of £3150 for the Ruddington water scheme, but that sanction had been deferred with regard to the loan of an additional £850 for future extensions until the Council were actually prepared to carry them out.

LEGAL INTELLIGENCE.

SUPPLYING WATER BEYOND STATUTORY LIMITS.

Bristol and West Gloucestershire Companies' Case.

In the Court of Appeal last Wednesday, the Master of the Rolls and Lords Justices Farwell and Kennedy had before them an appeal by the West Gloucestershire Water Company from the order of Mr. Justice Neville, restraining them from supplying water to any person in the parish of Henbury, or in any other place or places outside the area within which they were authorized by Statute to supply water. The proceedings in the Lower Court were reported in the "JOURNAL" for the 2nd of March (p. 634). The dispute between the parties arose with regard to a large house called Hollywood Towers, with a model dairy, gardener's cottage, stables, &c., attached, belonging to Sir George White, and occupied by his son. It is situated partly within the parish of Henbury, in the district of the Bristol Water Company, but very near the border of the parish of Almondsbury, which is within the defendant Company's district. Their main came to a dead-end in the high road near the property in question, but was continued a short distance outside their limits to a hydrant and overflow, for the purpose of allowing accumulations of muddy water to be run off. Above this, just outside defendants' district, a service-pipe was taken off to supply the house; and the contention of the plaintiffs (the Bristol Water Company) was that the delivery of the water was not at the point in the main within the defendants' district, but at the house, which was beyond their limits. It was contended for the appellants, for whom Sir Alfred Cripps, K.C., and Mr. Christopher James appeared, that the real place of delivery was where the water left the main, and that therefore the supply was not outside their district. Their Lordships, without calling upon the respondents' Counsel, Mr. Upjohn, K.C., and Mr. Cann, dismissed the appeal with costs; holding that a statutory company could only do what they were authorized to do by their Acts, and if these provided that water should only be supplied within prescribed limits, they could not carry on business outside them.

Unsuccessful Action against the Alliance and Dublin Consumers' Gas Company.

Last Friday, in the Irish Probate Court, before Mr. Justice Andrews and a Special Jury, the trial was concluded of an action in which Messrs. Forrest and Son, Limited, of Grafton Street, Dublin, were plaintiffs, and the Alliance and Consumers' Gas Company defendants. The plaintiffs alleged that the defendants, in disconnecting and removing gas cooking-stoves, which they had hired to the plaintiffs, neglected to use due care and skill, and, as a consequence, an explosion took place on the plaintiffs' premises on Nov. 1, doing very considerable damage to property and injuring one of their employees. The plaintiffs claimed £14,799 damages, made up of £2018 for injury to their buildings, £11,770 injury to the contents of the buildings, £902 cost of fitting up and rent of temporary premises during the repair of the building, &c., and £108 for injury to adjoining property. The defendants denied that the explosion took place by reason of any neglect on their part, and pleaded that it was caused by the negligence of the plaintiffs and their servants in the care, working, and management of the cooking-stoves and meter, gas pipes, fittings, and appliances attached thereto and used in connection therewith. The Jury found that the explosion was not caused by any negligence on the part of the Gas Company's servants; and a verdict was entered for the defendants.

Conviction for a Bogus Sale of Gas Shares.

At the Somerset Assizes last Thursday, Thomas William Wrightson (41) was indicted for unlawfully obtaining by false pretences from Mr. Henry Smith Lewis a banker's cheque and order for £25 5s., with intent to defraud, at Axbridge, on the 15th of March last. Mr. Vachell was Counsel for the Crown; the accused conducted his own defence. Mr. Vachell said prisoner represented that he was a stockbroker in London, and was carrying on a genuine business under the name of G. F. Sutton, Sons, and Co., at No. 145, High Holborn. He said he had for sale five fully-paid £5 shares in the Axbridge Gas Company, and the plaintiff was induced to buy them; but he had never received the shares or the return of his money, and the prosecution alleged that Wrightson was not a stockbroker at all. The address given by him was a room on the third floor, and he did no genuine business there. Prisoner was carrying on, or pretending to carry on, the business of a stockbroker at other places under other names. The prosecutor—a baker of Axbridge, and a Director of Axbridge Gas Company—was called, and stated that on the 13th of March he received a circular from "G. F. Sutton and Sons," stating that they were instructed to sell five shares in the Axbridge Gas Company. His wife sent a telegram purchasing the shares; and he subsequently drew a cheque for £25 5s. on the Wilts and Dorset Bank in payment. The cheque had been duly honoured; but he did not receive the shares. He received a number of type-written letters delaying their delivery on some pretext or other, till at length he placed the matter in the hands of the police. He knew there were only two blocks of £5 shares, and one of these was held by his niece in London. Prisoner addressed the Jury, and said the prosecution was based on a misrepresentation of the facts. There was no evidence in support of the false pretence. He afterwards went into the witness-box and swore that Joseph William Willis, of Bridgwater, instructed him on the 26th or 27th of February to sell five shares in the Axbridge Gas Company, and he sold the shares, which he had not got. The certificate of Mr. Willis's death was put in, and was to the effect that he died on the 6th of March. Prisoner was found guilty. He admitted a previous conviction, and was sentenced to four years' penal servitude.

MISCELLANEOUS NEWS.

INSPECTION OF GAS LIQUOR AND OTHER WORKS UNDER THE ALKALI ACT.

District Inspector's Reports.

In the last number of the "JOURNAL," the report of the Chief Inspector under the Alkali Works Act, 1906 (Mr. R. Forbes Carpenter), for the past year was dealt with. To-day we give some extracts from the reports of the District Inspectors.

The first district is Ireland, which is under the supervision of Mr. E. G. Ballard. He says that, on the whole, the sulphate of ammonia works are carefully conducted; only two cases having occurred where complaints of any kind had to be made. In one of them, the oxide in the purifier was hardly fresh enough to last out the run which was just commencing; and in the other, sulphuretted hydrogen was creeping up the wall of the purifier between the oxide and the brickwork. In both instances the cause of complaint was removed before the Inspector left the premises. In two more works, continuous stills were substituted for the old-fashioned intermittent ones. Taking all the places where sulphate of ammonia is made in Ireland, the number of works absorbing the sulphuretted hydrogen in oxide of iron is 36; and in two works it is burnt. There are 32 works operating on the continuous system of distillation and six on the intermittent system. Products equivalent to 2768 tons of sulphate of ammonia were made during the year.

In the North of England district, which is now under the supervision of Mr. E. Morley Fletcher, who succeeded Mr. John W. Young about the middle of last November, there are seven additional sulphate of ammonia works; and one ceased to register last year. The report on the work of the district has been prepared, at the request of the Chief Inspector, by Mr. Young. In all, 77 works produced sulphate of ammonia, and one liquor ammonia. The output from coke-ovens increased 12 per cent. during the year; but that from gas-works remained stationary. There was 9·9 per cent. of the sulphate made in connection with vitriol plants, and 13·3 per cent. in connection with the Claus process; the acidity of the gases from the exits of the latter averaging 0·7 grain of sulphur trioxide per cubic foot. There was no cause for complaint against either class. As before, the greater number of works use oxide purifiers; 45 works producing 25 per cent. of the total sulphate. In 15 cases the purifiers are on the heap system. Mr. Young says it is interesting to note how in the ordinary form of box purifiers the oxide is not generally employed to the best advantage. At one works there are two purifiers, each 20 feet square and 5 feet deep. The annual make of sulphate is from 450 to 500 tons; and the whole process is carefully supervised. When in use, the gas is diverted to them alternately every 12 hours, and while at rest they are gently revivified by chimney draught. Mr. Young was informed by the engineer, who gave him permission to present the above figures, that the oxide remained for a year unhandled, except that round the inner walls of the purifiers for a space of 18 inches the material was deeply trenched on three occasions, and fresh oxide filled in.

In the district comprising Cheshire, North Wales, and part of Lancashire, which is under the supervision of Mr. E. G. Ballard, there were 20 works registered last year for the manufacture of sulphate of ammonia, excluding two transferred to another district. All the works were carefully conducted. The heap form of purifier for the absorption of sulphuretted hydrogen still holds its own, and continues to be further adopted. In every case it is giving satisfaction, as being far more easily managed (thus effecting a saving of labour) than the old box form of purifier. No complaints arose from this manufacture; and the various plants were kept in a good state of repair. Taking all the sulphate of ammonia works in the district, the number using continuous distillation plant is 21. The last plant on the intermittent system was replaced by a continuous still during the past year. The methods by which the sulphuretted hydrogen evolved in the process of manufacture is dealt with at the various works in the district are as follows: To vitrol chambers, none; by Claus process, 2; by absorption in oxide of iron, 19; by combustion, none; by special process, 1. The proportion of sulphuretted hydrogen treated by the above different processes, in terms of sulphate of ammonia made, and percentage of total make, is as follows: To vitriol chambers, none; by Claus process, 4·3; by absorption in oxide of iron, 27·2; by combustion, none; precipitated by metallic salts, 68·5. There are three works in the district in which gas liquor is concentrated for shipment to works where it is utilized in other manufacture. This class of work was carefully conducted; and no complaints arose of noxious gases.

In the district comprising Widnes, Runcorn, and Liverpool, which until September was under the sole supervision of Mr. Ballard, but subsequently supervised by him in collaboration with Mr. Herbert Porter, there were more gas liquor and sulphate and muriate of ammonia works last year than before, owing to the extension of the district. The following are the different methods of treating the sulphuretted hydrogen evolved, in terms of the percentage of sulphate of ammonia made: Absorbed by lime, 13·9; by combustion, 10·1; by other methods, 76. All the plant in this class was properly worked and maintained during the year. The six tar-works in the district were kept in good order.

In conjunction with Mr. Young, who entered upon his duties in September, Mr. Porter had the supervision of the district comprising North and East Lancashire and Yorkshire, in which there are 13 liquor works, and 46 works producing sulphate or muriate of ammonia. The proportion distilled by the continuous process is 97·5. The methods of dealing with the foul gases are (expressed in percentages): To vitriol chambers, 30·5; absorbed by lime or oxide of iron, 34·3; by Claus process, 19·9; by other methods, 15·3. These figures show only slight variations from last year. The Claus process has given excellent results in the yield of sulphur in works where careful study has led to the adoption of improvements in the construction of plant. The best yield of sulphur is 6·6 tons per 100 tons of sulphate made, the next best being 5·5 tons of sulphur. As a result of this improvement, the total

acidity of the gases leaving the sulphur-depositing chambers is much lower. In one works it rarely exceeds 2 grains of sulphur trioxide per cubic foot, with only slight traces of sulphuretted hydrogen, which are afterwards absorbed in oxide purifiers. Much of the improvement has been effected by placing the kiln on the top of a brick chamber, so that the gases pass down through the packing in the kiln in a uniform manner; the bottom of the kiln being open all over below the grid. As mentioned in the last report, a superficial area of 4 square feet in the kiln per ton of sulphate made in 24 hours appears to be most effective; greater or less space not giving such good results. At two large works the sulphuretted hydrogen is burnt in the oxide burners for the production of sulphuric acid; and at one works experiments have been continued since last year in trying to remove the tar mist in the gases, which is detrimental to the acid manufactured. All the works in this class were maintained in proper order during the year; and there was no case of infraction due to foul purifiers or escaping gases.

Coming to the East Midland district, of which Mr. E. Morley Fletcher has charge, the manufacture of sulphate of ammonia was commenced in three additional places—one a gas-works, and the other two coke-oven works where bye-products are recovered. Again there was a large increase in the quantity of sulphate made in the works of the latter class. The total quantity of liquor distilled was equal to 27,840 tons of sulphate. The proportion of sulphate and muriate of ammonia made by continuous processes was 99·1 per cent. The percentage of sulphuretted hydrogen treated by the various methods of disposal, expressed in terms of the sulphate equivalent of the liquor distilled, was as follows: To vitriol chambers, 14·4; by Claus process, 24·1; by oxide purification, 22·4; by combustion, 39·1.

Mr. E. Jackson has something interesting to say about the South Midland and Norfolk district, in which 100 works are registered where the manufacture of sulphate, chloride, or carbonate of ammonia or the concentration of gas liquor is carried on. In consequence of the re-arrangement of the boundaries of the districts adjoining, 22 works for the manufacture of sulphate of ammonia (with six exceptions, mostly small plants at gas-works scattered over a rather large area) were transferred to another district, six works were brought in, and a like number of new works for the manufacture of sulphate were registered during the year. At three of the new works the plants are erected at gas-works. The usual continuous stills, with hand-fishing saturators, have been put down. At one works, one oxide purifier only has been attached; in another, two purifiers, with hydraulic change-valve; and in the third, two oxide heaps are employed, with suitably concreted floor and also an hydraulic change-valve. The fourth new works are attached to a plant where ammoniacal liquor is obtained by a special coal-distillation process. A continuous still is erected here, and the usual hand-fishing saturator; two oxide heaps being attached, with a hydraulic change-valve. The fifth sulphate plant is connected with coke-ovens, and the saturator gases are returned to the condensers and scrubbers of the gas plant. What remains, being thus mixed with the gases used for heating ovens and boilers, is subsequently burnt. The increase in the total acidity of the chimney gases by the adoption of this method of disposing of the noxious gases was not found, from a series of tests taken, to be too great to require any alteration of method before the works could be passed for registration. No trace of sulphuretted hydrogen has been found in the flue gases. In all the foregoing new works, the "devil" liquor from the condensers is returned to the crude-liquor well. There are already in the district 16 coke-oven works with recovery bye-product plants, and at two more collieries patent ovens are being erected. There are also four works where coal is carbonized in retorts for products. The sixth works consist of large power-gas sulphate of ammonia apparatus of the usual type. The number of works using the continuous method of distillation is 94; and the proportion of liquor distilled by the continuous process is 99·7 per cent. The following figures show the proportion (expressed in percentages) of gas liquor produced in the district from the different sources, worked out on a sulphate of ammonia basis: Gas-works, 61·2; iron-works, 2·9; producer gas, 4; carbonizing (coal) works, 4·1; and coke-ovens, 27·9. It is interesting to note the gradual increase in the figure for the coke-ovens in the district during the last five years: For the year 1904, the relation was 7·9 per cent.; for 1905, 9·8 per cent.; for 1906, 15·4 per cent.; and for 1907, 20·9 per cent. If the sulphate of ammonia produced at iron-works (from blast-furnace gases) and producer-gas and coal-carbonizing plants are added to the coke-oven figures, the increase in proportion between the sulphate obtained from these sources and that from ordinary gas-works plants is considerably more. The percentage from all these various sources, other than gas-works, in 1904 was 16·9; in 1908 it had risen to 38·9. Thus, of the total sulphate of ammonia produced in the district, only 61 per cent. is now obtained from ordinary gas-works liquor.

Reporting upon the district embracing the South and South-West of England, Dr. A. C. Fryer states that there are 95 registered works where the manufacture of sulphate and muriate of ammonia is carried on. Two new sulphate of ammonia plants were registered during the year; both being provided with good condensers and oxide of iron purifiers. In a few cases the oxide purifiers were found to be overworked, and complaint had to be made. These, however, were isolated instances, and the reason was usually uneven charging. The use of heap purifiers continues to extend. This form of purifier was first used by Mr. John J. Jervis, the Manager of the New Swindon Gas-Works, in 1886. In the annual report for 1887, it is stated that "this form of purifier is not only simple and inexpensive, but performs its work effectively."* Dr. Fryer says this statement can still be endorsed as correct; and at the present time 43 per cent. of the sulphate of ammonia plants are fitted with oxide of iron heaps where this material is employed for absorbing the sulphuretted hydrogen. The number of works in the district using continuous distillation plants is 68; those using the intermittent system being 25. The proportion of liquor distilled by the former process is 93·6 per cent. Purification by oxide is employed in 86 works.

In South Wales and Monmouthshire, which are under the supervision of Dr. T. Lewis Bailey, ten of the works registered are gas-works, or others dealing with the liquor from gas-works, and four are coke-ovens with bye-products plant. The total amount of ammonium salts, in terms of sulphate of ammonia, shows an increase of 12·5 per cent. over the previous year, for which increase coke-oven plants are mainly responsible. One sulphate plant was entirely renewed during the past year; and the plant generally in all works was kept in an efficient state of repair. In several instances it was necessary to insist on better cooling of the foul gases before they passed to the oxide of iron purifiers or heaps; but, speaking generally, the purification of the exit gases was efficiently carried out.

The last report of the series furnished by the District Inspectors is that of Mr. F. Napier Sutton, in whose district, comprising the Eastern and South-Eastern counties, there are under supervision 89 works concerned with the treatment of gas liquor. The total quantity of ammoniacal compounds manufactured in the district in the past year was much the same as in 1907. The products manufactured consist chiefly of sulphate, but include carbonate and nitrate of ammonia, and liquid (concentrated and refined) and anhydrous ammonia. With the exception of a few hundred tons obtained in the manufacture of bone charcoal, the whole of the production is derived from the carbonization of coal in the gas-making industry of the district. The gas-works belonging to statutory companies and local authorities furnished 90·3 per cent. of the products, and the rest was made in the works of private firms. An increased quantity of ammoniacal liquor was treated by the desulphurizing process in use at one works in the past year. The plant for this purpose was remodelled in 1907 and made more continuous in action, whereby the liquor completes a larger number of cycles before passing on for the final recovery of the ammonia. The equivalent, in terms of sulphate, of the liquor desulphurized is added to the total make of sulphate in the following statistics, and is included for the purpose of calculating the proportion of sulphuretted hydrogen dealt with by the various methods of disposal: Total quantity of liquor distilled, equivalent to 52,385 tons of sulphate; number of works using continuous distillation plants, 82; proportion of liquor distilled by the continuous process, 99 per cent.

The Claus sulphur-recovery process is in use at nine works in Mr. Sutton's district; and 13 units of plant are in operation. Absorption of the foul gases in oxide of iron is the method used at 60 works; and the proportion of gas so treated amounts to 9·3 per cent. The use of oxide heaps in place of the open box form of purifier continues to extend in popularity as the advantages of the system are appreciated; and the heap purifiers are now in use at 21 works in the district. Hitherto this form of purifier has chiefly been in use at small and moderate-sized works; but the method has recently been adopted in place of the Claus process at works where the daily make of sulphate reaches 7 tons. Two pairs of oxide heaps are arranged upon a cemented floor, and each heap is regulated by a separate hydraulic change-valve. The pairs are worked alternately, and generally deal with a make of from 50 to 60 tons of sulphate before requiring change and renewal; and the cost for labour is low. The number of works at which the gases are burnt in a special kiln, with subsequent neutralization of the acid products, is now 11. In two instances the method is used in conjunction with the Radcliffe process for the removal of sulphocyanide in the spent liquor, and for decolorization of the effluent. The average neutralizing efficiency of the plants reached 92·5 per cent. in the past year; while the majority of them yielded upwards of 95 per cent. neutralization. The disposal of the saturator gases by passing them into the crude gas-main, and so to the purifying system, is practised at three works.

The distillation of coal tar and gas tar is carried on in the districts under consideration at 19 works of greatly varying distillation capacity. No additions to plant have to be recorded. There are in use in the district 109 intermittent pot stills and four of Lennard's patent continuous stills, the largest of which treats 24,000 gallons of dehydrated tar per diem. At the larger works, the more complete separation of tar and water is practised by the preliminary heating of the raw tar in bulk, whereby the subsequent distillation process is materially curtailed. But at many of the smaller works such facilities do not exist; and tar is frequently in the stills for two days—the first being occupied in the troublesome task of getting the stills to "stand fire," and the second for the distillation proper. Mr. Sutton thinks more attention to this matter should lead to greater economy. Complaint has on several occasions been made of the evil-smelling gases evolved during the distillation of water-gas tar; and he says it is evident that certain noxious gases other than sulphuretted hydrogen pass through both oxide and lime purifiers. Very strong complaints were made recently in respect of one works where this tar alone is distilled. The lime purifier was greatly increased in size, and while the lime showed no sign of fouling, the nuisance continued. Treatment by absorption has, therefore, been abandoned for combustion in the boiler fire; and this alteration of method appears to have put an end to the trouble.

Report to the Secretary for Scotland.

Following the reports of the District Inspectors is the Chief Inspector's report to the Secretary for Scotland. The details of the work done in this portion of the United Kingdom are, as usual, furnished by Mr. W. S. Curphey; and we extract the following particulars.

The number of works in Scotland registered under the Alkali Act during the past year was 163—an increase of five over the corresponding number in 1907. Nine new works were admitted to the register, and in four cases registration for 1908 was not renewed. Of the total number, nine were registered as "alkali" works; and in the case of 154, one or more of the various chemical processes enumerated in the first schedule to the Act were carried on. These processes numbered 267, compared with 260 the previous year. The quantity of salts of ammonia made (expressed as sulphate) was—

	Tons.
Gas liquor works	19,794
Iron works	16,737
Shale works	53,628
Producer gas, coke, and carbonizing works	15,311
Total	105,470

* The apparatus referred to was described in the "JOURNAL" early in 1888 (see Vol. LI., p. 553).

The make in 1907 was 103,342 tons. The number of registered works in Scotland in which sulphate, chloride, or hydrate of ammonia was made during 1908 was 98; being nine more than in 1907. The increase in numbers was due to the addition to the register of eight gas-works in which sulphate manufacture was commenced, and of one new coke-oven works which started operations. This class of works now comprises 16 iron-works, 13 shale-works, 10 coke, gas-producer, and carbonizing works, and 60 gas-liquor works—one being both carbonizing and gas-liquor works. For several years past an increase in the number of works in which gas liquor is treated for the manufacture of sulphate of ammonia has had to be reported; and Mr. Curphey says that further additions may be looked for. During the past ten years, the number of such works has risen from 9 to 41, or more than fourfold in this short period. The number of works using continuous distillation plant is 60; and the whole of the liquor is dealt with by this method. The sulphuretted hydrogen evolved in the process of manufacture was dealt with by various methods in the following proportions, expressed in terms of sulphate of ammonia and percentage of total make: Claus process, 10·9; oxide of iron purifiers, 79·3; combustion, 8·4; metallic salts or other methods, 1·4. These figures do not include the ammoniacal liquor obtained in iron-works, shale-works, coke-oven works, or producer-gas works. In all these works the continuous method of distillation is now universal. The production of sulphate of ammonia in Scotland from all sources amounted to 105,470 tons—an increase of fully 2000 tons over 1907. Despite a further diminution in the yield from iron-works, the increased production made from gas liquor and in shale and coke-oven works was sufficient to give the net increase noted.

Mr. Curphey presents, in continuation of previous annual records, some interesting statistics on the production and recovery of ammonia in Scotland last year. The coal fed blast-furnaces in Scotland contribute nine-tenths of the total recorded under the head of "iron-works" in the table given in the "JOURNAL" last week (p. 707). In the years 1906 and 1907, the sulphate of ammonia recovered in iron-works in Scotland amounted to 20,204 tons and 19,719 tons respectively; but in 1908, owing chiefly to the great depression in the iron industries, only 16,737 tons were recovered from this source. The average numbers of furnaces in blast in the years named were 90·35 and 90·44 respectively; while in 1908 this figure had dropped to 75·95—a reduction of nearly one-sixth. The Chief Inspector remarks that the two years were years of maximum activity; and it may possibly be the case that, with the increasing scarcity of coal possessing sufficient hardness to stand internal crushing in the blast-furnaces, conditions will not again favour so large a return of sulphate as that recorded in 1906.

In continuation of the table presented in recent annual reports of the progress of shale distillation and ammonia recovery, Mr. Carpenter gives the figures compiled from the statistical returns to the Home Office on Mines and Quarries for the ten years ended Dec. 31 last The figures show that the total quantity of shale mined in the United Kingdom in 1899 was 2,210,824 tons; the amount of sulphate of ammonia recovered being 38,780 tons, or 39·3 lbs. per ton of shale. In 1904, the figures were 2,333,062 tons, 42,486 tons, and 40·8 lbs.; while last year they were 2,891,564 tons, 53,628 tons, and 41·5 lbs.

BIRMINGHAM CORPORATION GAS DEPARTMENT.

Reorganization Scheme and the Salaries Question—Price of Gas for Manufacturing Purposes.

At the Meeting of the Birmingham Corporation last Tuesday, the questions of the reorganization of the Gas Department and the salaries of the officials were again under consideration. The amended scheme of the Gas Committee was set forth in the report given in the "JOURNAL" for the 8th inst. (p. 657).

Alderman Sir HALLEWELL ROGERS, in proposing the adoption of the scheme, said the Council would remember that at the meeting on the 11th of May the Gas Committee brought forward a scheme for the future working of the department, and it was defeated by two votes in the Council. It was evident from the debate that took place that no opposition was offered to the scheme itself, but only to the proposal made by the Committee, asking the Council to agree to maximum salaries for four of the principal officers, and empowering the Committee from time to time to raise their salaries within the maxima. He would not reopen the discussion on the question except to say that he was firmly convinced that, in the interests of the ratepayers, generally it was necessary, for the proper working of the department, that the Committee entrusted by the Council with such wide responsibility should be given an absolutely free hand on this point; and he expressed the hope that at some future meeting the Council would review the matter. With regard to the scheme of reorganization, he reminded the Council that it was tentatively sanctioned by them a year ago, and that it had proved so successful that the Gas Committee were unanimous in their recommendation that it should be permanently established. The pith of the scheme lay in the fact that it was a combination of the engineering and commercial elements, which, working in harmony together, produced the best financial results, and ensured that no experiment should be tried and no work undertaken without being thoroughly considered, not by one engineer, but by a Committee consisting of the Engineers-in-Charge of all the works, the Chief Chemist, and the head of the commercial department who was responsible for its financial success. Their officers were all tried, and if they were not, in the opinion of the Committee, thoroughly competent to undertake the various duties they now recommended, they would not bring the scheme before the Council.

Alderman EDWARDS seconded the proposition; and it was agreed to.

Alderman Sir HALLEWELL ROGERS then proposed a resolution

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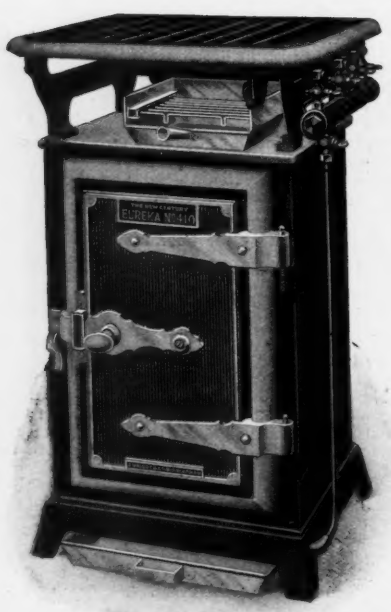

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BIRMINGHAM.

No. 195.

increasing Mr. Hampton Barber's salary as Secretary of the department from £1400 to £1600, the advance to date from the 1st inst. He said the recommendation of the Gas Committee was unanimous. Mr. Barber had been with them for eight years, and during this time he had given the utmost satisfaction to the Committee. They had all been struck with his business capacity, his executive ability, his powers of organization, and his astuteness in purchasing and selling materials. He had no hesitation in saying that during Mr. Barber's term of office he had greatly helped to develop and strengthen the whole business of the gas undertaking. Those members of the Council who had served on the Gas Committee must have realized the magnitude and complexity of the business, and the absolute importance—nay, necessity—of grappling with all the details, and of organizing and controlling the large staff needed for its effective administration. He would remind them that it was the largest commercial undertaking in Birmingham, having a capital of about £3,000,000, and an annual income of some £1,000,000. It was the greatest municipal gas undertaking in the country, and the third largest gas undertaking in the United Kingdom. Since 1901, when Mr. Barber entered their service, the number of consumers had increased from 85,000 to 135,000, and the annual sales of gas were more by 1300 million cubic feet. One of Mr. Barber's principal duties was to negotiate and complete the purchase of hundreds of thousands of pounds' worth of coal, oil, and other stores each year; and if he told the Council that 1d. per ton on the coal purchased annually amounted to £2500, and ¼d. per gallon on the oil required for carburetting gas amounted to the same figure, they would see that, unless they had a keen business man, in these two transactions alone thousands of pounds might be lost to the ratepayers. Having obtained what they believed to be an able administrator, he would remind the Council that they would get the best of his services if he felt that he had the confidence and support of those under whom he was directly serving. Mr. Barber had not been with the department many months when, dissatisfied with the income they were deriving from residual products, he personally took the sales in hand; and, by securing new and more remunerative markets, the department had obtained for these products alone an increased income during the past eight years of no less than £496,000. After allowing for the greater volume of trade in the later period, there had been a net increased profit during the past eight years of upwards of £400,000—an average of about £1000 per week during the entire period. Early that year, upon the Secretary's advice, and before the usual time for inviting tenders, the Committee authorized him to purchase considerable quantities of coal; and it would be satisfactory to the Council to know that their requirements had been secured at a saving of approximately £15,000. During his service with the Corporation, an average of £22,000 more per annum had been contributed in aid of the rates; while the price charged for gas had been lower, and in fact to-day was the lowest in the history of the undertaking. An increase in the salary of an official in a commercial department did not necessarily mean increasing the rates of the city—in fact, it generally had exactly the opposite result. A thoroughly competent official was able to save thousands of pounds to the ratepayers. The Committee were unanimous in their opinion that the position of Secretary and Manager, with all the responsibilities it involved, was worth at the present time a salary of at least £1600 per annum; and he had no hesitation in saying that were theirs a commercial company the remuneration would be very much larger. In at least two instances of gas companies in this country, the commercial managers received salaries of more than £2000 per annum; and one of them, which was one of the most prosperous in the country, was not more than half the size of the Birmingham undertaking. The present Secretary was untiring in his efforts to further develop the business of the department, to extend its usefulness throughout the area of supply, and to render the undertaking still more profitable. He trusted the members of the Council would agree with the Gas Committee that it was in the best interests of the city that they should recognize and encourage such service as the Secretary had rendered. They were anxious to maintain the present degree of efficiency in the conduct of the business, and hoped the Council, if they had confidence in their judgment, would support their recommendations to this end.

Mr. NEWEY seconded the proposition.

Mr. GAUNT strongly opposed the resolution, and pointed out that if it were passed Mr. Barber's salary would have been increased by £600 in five years. The Secretary's experience had been gained, he said, at the expense of the city. He objected to the amount handed over by the Gas Committee being called profits. If the Gas Committee charged the consumers at the same rates as in other cities, and then made a profit, it would be a different matter. In addition to these reasons, he did not think they were justified in granting an increase at the present time, when the trade of the city was in such a depressed state. He believed in paying a fair market price for all services rendered; but he thought the Council had already acted generously. If they passed the resolution, they would be unjustifiably extravagant; and if the Council two years ago had thought that another advance would be asked for so quickly, they would not have readily granted the increase on that occasion.

Mr. WALTHALL remarked that the general opinion of the ratepayers of the city was against any increase of the Secretary's salary. He agreed as to the ability of Mr. Barber, but pointed out that the latter's duties did not involve the sole management of the gas undertaking. He was not responsible for the manufacture and supply of the gas; these duties being performed by most competent men with scientific knowledge.

Mr. NETTLEFOLD, in supporting the resolution, referred to the latter statement by Mr. Walthall, who, he said, should know that they required to have a business man to look after the whole concern. Experts could not be done without; but they must be directed and controlled by business men. He might point out that in 1900 the aggregate salaries in the Gas Department amounted to £5280, and in 1909 to £4740. Supposing the proposed increases were granted, the total

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salaries would be £5265, or no more than they were in 1900, when their profits were only two-thirds of what they now were.

Alderman BEALE reminded the Council that during the last few years the whole of the methods of the Gas Department had been changed; and this had placed increased responsibility on the principal official. It seemed to him, therefore, that, as a necessary consequence, the remuneration should be raised in accordance with the increased responsibility.

Mr. PENTLAND remarked that anyone who went about the city would tell the Council that Birmingham people were not in favour of the advance suggested. He personally was in favour of the increase to the Engineers; but he honestly believed the present was not the time for raising the salary of the Secretary from £1400 to £1600 a year.

Alderman HUNT, speaking in opposition to the proposal, said the returns of the last eight years had been the result of the excellent management of the previous fifteen or twenty years; and Mr. Hampton Barber came into a wonderful heritage. The men who really saved the ratepayers' pockets were the men at the works, who only received half Mr. Barber's salary.

Mr. BROOKS said there was a strong feeling outside the Council against the increase; and he personally was rather apprehensive that it was only a step towards the £2000 previously mentioned by the Committee. If so, he thought that there would be considerable difficulty in passing it through the Council. He moved, as an amendment, that the salary of Mr. Hampton Barber be increased from £1400 to £1600 as from June 1, 1910.

Mr. DAVIS seconded the amendment; and after further remarks,

Alderman Sir HALLEWELL ROGERS replied to the discussion. He said it had been suggested that the proposal before the Council came from Mr. Hampton Barber himself; but there was no truth whatever in the suggestion. The recommendation came direct from the Gas Committee, and was consequent upon the reorganization scheme, which placed additional responsibility on the shoulders of the Secretary. Alderman Hunt had given it as his opinion that the success of the department was due entirely to the seeds sown fifteen years ago. He (the speaker) admitted that it was owing in a large measure to the work then accomplished, but not entirely. Mr. Hampton Barber, by his treatment of residuals, had increased the profits of the department by several thousands of pounds. In appealing to the Council to have confidence in the Committee, Sir Hallewell said they would certainly not have brought forward the proposal had they not considered it fair and just.

On the amendment being put to the vote, it was lost. The resolution was then submitted; and it was rejected by 33 votes to 28.

The Council then agreed, without discussion, to the following increases of salaries of the Engineers-in-Charge, to date from the 1st inst.: Mr. J. Foster (Windsor Street), from £650 to £700 per annum; Mr. W. Chaney (Nechells and Adderley Street), from £625 to £700 per annum; Mr. F. J. Bywater (Saltley), from £425 to £600 per annum; and Mr. T. H. Hack (Swan Village), from £375 to £400 per annum.

Alderman Sir HALLEWELL ROGERS then moved that as from next Michaelmas the price of gas used for certain heating purposes should be reduced by 3d. per 1000 cubic feet on the current lighting rates. He said though this matter had directly arisen from a memorial from the Birmingham Chamber of Commerce, it had been before the Council on more than one occasion. It was obviously the duty of the Gas Committee not only to assist in every possible way the manufacturers of the city, who were their largest customers, but to protect the gas undertaking itself from any competition that might arise, and to obtain as large an output as possible, for this alone enabled them to supply gas to the smaller consumers at comparatively low prices. The difficulty in dealing with this question had been to ascertain exactly the quantity of gas consumed for manufacturing purposes other than for gas-engines. They did not feel prepared, therefore, to recommend that gas used for manufacturing purposes should be at once supplied upon the same terms as gas for motive power. Thus the scheme was to this extent a tentative one, and must be reconsidered when they had the exact position before them, and had ascertained more nearly the quantity of gas that would be consumed at the reduced charges. As far as could be learnt, the quantity of gas used for heating was probably one-fifth of the entire output. Competition with other heating agents had rendered it necessary for the department to meet the market, if they were to retain the trade; and as at the price now proposed there would be a satisfactory margin of profit, the Committee considered it was in the interests of the city that the proposed reduction should be made.

Mr. NEWEY seconded the motion; and it was carried.

Owing to the length of the proceedings, three resolutions bearing upon the salaries of officials in the service of the Corporation, of which notice had been given by Mr. Manton, were withdrawn.

REINSTATEMENT OF ROADS IN LONDON.

At the Meeting of the London County Council last Tuesday, the General Purposes Committee reported that the Metropolitan Water Board had inquired whether the Council would be prepared to enter into a written agreement with the Board regulating the terms upon which the reinstatement of streets or pavements broken up by the Board in pursuance of their statutory powers should, in cases where the Board are liable for the cost of reinstatement, in future be carried out by the Council, and indemnifying the Board against any damage or loss owing to defective reinstatement. The Committee pointed out that it had been the practice, where the property of the Council is affected, for the Council, with the assent of the Board, to reinstate the ground, though the Board have the right to reinstate footways and roadways disturbed in connection with the laying of their pipes and mains. After consideration of the reports of the officers, they were of opinion that this practice should be continued, and that an agreement should be entered into with the Board on the lines suggested by them. They

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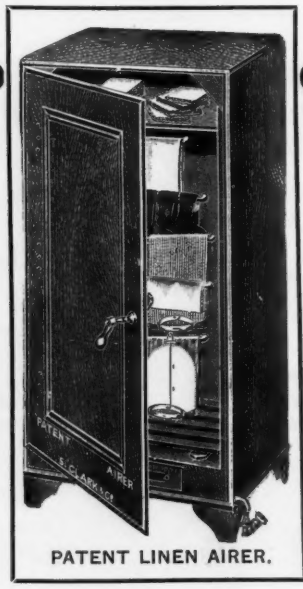

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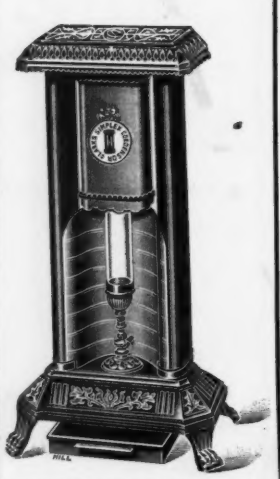
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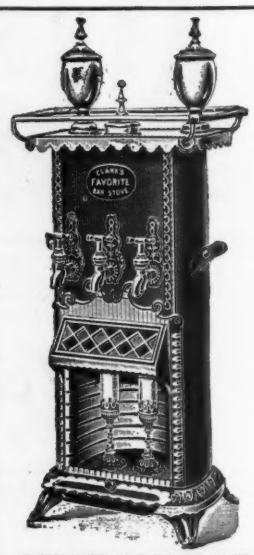

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accordingly recommended—"That the Council do enter into an agreement, in a form to be approved by the Solicitor, with the Metropolitan Water Board, regulating the terms upon which the reinstatement of streets or pavements broken up by the Board in pursuance of their statutory powers should in future be carried out by the Council, and indemnifying the Board against any damage or loss owing to defective reinstatement."

PRESENTATION TO MR. AND MRS. CHARLES HARRISON.

The annual picnic of the officials employed by the Accrington District Gas and Water Board took place last Wednesday, at Coniston, which place was reached viâ Fleetwood and Barrow-in-Furness. Mr. Councillor Dewhurst, the Chairman of the Board, accompanied the party, along with Mr. Charles Harrison, the Engineer and General Manager. At the Sun Hotel, Coniston, the party had dinner, under the presidency of Mr. Dewhurst, who announced that a presentation would be made to Mr. Harrison in recognition of his forty years' connection with the gas undertaking. A congratulatory telegram was read from the members of the Accrington District Club.

Mr. Gill, the senior member of the official staff, made the presentation (consisting of a diamond ring) to Mr. Harrison, and briefly reviewed the progress of the undertaking during his term of office. He said Mr. Harrison had served under six Chairmen, and had given satisfaction to all in his capacity as General Manager. Mr. Harrison had always been a man of order, system, and method, and a capable Manager of their large combined undertaking, with a capital of £401,284 in the gas and £517,713 in the water portion. There were 77 miles of gas-mains and 72 miles of water-mains in the district; and Mr. Harrison had behind him no less than fifty loyal officials, who held him in the highest esteem. He (Mr. Gill) knew that, in the districts supplied, Mr. Harrison had made many friends, and among the gas managers of Lancashire and the country he was widely known and much respected.

Mr. Harrison, in acknowledging the gift, expressed his pleasure at being with them on this occasion. He thanked all present for their devoted services in the past, extending over many years, and said the Board had an excellent body of officials to look after their interests. He appreciated the presentation, and felt delighted that he had the good wishes of all with whom he had to work—many of them having seen long service.

The Chairman then asked Mr. Harrison's son, Mr. Cedric Harrison, who has just attained his majority, to accept a diamond and ruby ring, on behalf of his mother, who was not able to attend. Mr. Dewhurst said Mrs. Harrison had the sympathy of all present, and they insisted that in any form of presentation she must be taken into account.

Mr. Cedric Harrison expressed his pleasure that he had the duty to perform of handing to his mother so valuable a token of the officials' respect and esteem. He was proud to witness the proceedings of the day, and hoped to follow in his father's footsteps.

Mr. Clayton, the Works Manager, moved a vote of thanks to the Board for granting the day's holiday; and Mr. Holgate, in seconding the motion, said he hoped they would have a continuance of such pleasant meetings for promotion of goodwill among the employes.

In connection with the proceedings here reported, it may be of interest to give a sketch of Mr. Harrison's career. He was educated at the Accrington High School, and entered the service of the Accrington Gas and Water Company. After the first nine years' service, he went to Luton, as Assistant-Secretary and Manager to the Luton Water Company; afterwards for three-and-a-half years he was Assistant to the late Mr. George Garnett, the Engineer of the Ryde Gas Company. In 1877 a vacancy occurred at Accrington, and he was appointed Engineer and General Manager—a position he has filled with conspicuous success. The undertaking is an important one, supplying gas and water to a district comprising seven townships, besides the borough of Accrington, with a combined population of 90,000, and covering an area of 22 square miles. There are two stations for the manufacture of gas—one at Accrington and the other at Great Harwood; the latter having been duplicated since Mr. Harrison took office. The Board have just secured additional land at Great Harwood, and are now preparing for the erection of sulphate of ammonia and carburetting plants. The annual make of gas in 1877 was 112 million cubic feet; whereas last year it reached 452 millions. At an early stage Mr. Harrison launched out into the gas cooking and heating business, and opened with a combined exhibition in the Town Hall. There are now 6880 cookers and fires in daily use in the district. There are 6364 prepayment meters fixed, with an average yearly consumption of 10,726 cubic feet per meter. At the Accrington works, the retort-house has been enlarged, and carburetted water-gas plant of 500,000 cubic feet capacity per day put down. In the water branch, Mr. Harrison's capacity has been brought more into service, and comprises the completion of the Dean Clough embankment, the erection of the Cliffe pumping-station and filter-beds at a cost of £30,000, filter-beds at Mitchell's reservoir, and, just recently, the erection of a pumping-station at Altham and the laying of three miles of 15-inch pipes at a cost of £26,630. On the transfer of the property from the old Company to the Joint Board in 1894, but only after a strong parliamentary fight, Mr. Harrison's services were recognized in a tangible form by the retiring Directors; and he was unanimously appointed Engineer and General Manager under the new Board. Mr. Harrison joined the British Association of Gas Managers in 1880, passed into the Gas Institute, and is a member of the present Institution, as well as of the Manchester District Institution of Gas Engineers. Needless to say, Mr. Harrison enjoys the full confidence of the Board under whom he serves; and the handsome presentation just made to him is proof that the fifty subscribing officials also hold him in the highest esteem.

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AUTOMATIC LIGHTING AT NEWCASTLE-ON-TYNE.

Proposed Trial of Alder and Mackay Controllers.

Early in the present year, the Lamp Inspector of the Newcastle-upon-Tyne Corporation (Mr. George Lamb) presented to the Lighting and Tramways Committee a report on the automatic lighting and extinguishing of the public-lamps of the city; and it was noticed in the "JOURNAL" for the 26th of January (p. 259). The Committee's attention had been called by the Newcastle and Gateshead Gas Company to the advantages which would accrue to the Corporation by the adoption of a system of simultaneous lighting; and besides showing the Committee experiments in one of their works, they erected experimental apparatus in parts of the city which would, in their opinion, be most difficult to reach with a pressure wave. These experiments were eminently satisfactory, so far as proving the practicability of controlling the lighting and extinguishing of gas-lamps from a centre. As, however, other towns had adopted forms of apparatus varying in mechanism but controlled on two principles—viz., by pressure wave centrally, and by clockwork, each lamp with its own independent controller—a resolution was passed by the Lighting Committee, and confirmed by the Watch Committee, that a deputation accompanied by the Lamp Inspector should visit Bournemouth, Tottenham, Lambeth, Windsor, and Liverpool, to inquire into the various methods, the conditions of the districts in which they had been adopted, and the practicability of applying a system that would be satisfactory in Newcastle. The Committee's instructions were duly carried out; and besides the places named, the deputation also visited Gosforth and Darlington.

Interviews took place with Dr. Rostin, who exhibited several adaptations of his apparatus which had not yet been put upon the market; and in the course of conversation with the Committee he stated that he had upwards of 5000 of his appliances fixed in the London district. The deputation also interviewed Mr. Schwab, sole agent in England of the "Bamag" apparatus. Mr. Schwab explained it, and informed the deputation that in Germany upwards of 40,000 of these appliances were in actual use, and said he knew of no instance where it had been discarded after its adoption. An interview was also arranged with the representative of Messrs. Alder and Mackay at the Lighting Inspector's office. At other interviews, opinions were obtained from the officials of the borough of Lambeth, the British Gaslight Company, and other gentlemen of high standing in connection with the gas lighting world which were of great assistance to the deputation. They also obtained a copy of a communication on the subject made by M. Lhomme to the Société Technique last year. The deputation were received with great courtesy by the members of corporations, officials, and others with whom they had interviews; and in the report they have just presented on the result of their inspections (a copy of which we have received from Mr. Lamb), they express their sincere thanks for the ready manner in which information was at all times given.

The Committee deal in detail first with the Gunning clockwork apparatus at Bournemouth, next with the Rostin pressure-wave apparatus at Tottenham and Lambeth, then with Messrs. Alder and Mackay's system at Windsor, the Gunning, Horstmann, and Anderson systems at Liverpool, the Rostin, Alder and Mackay, and "Bamag" systems at Darlington, and the last-named system at Gosforth. Illustrations of the systems accompany the particulars furnished. At the close of their inspections, the deputation had interviews with Messrs. T. Waddon (Secretary), W. Doig Gibb (Engineer), T. Hardie (Manager of the Redheugh station), and J. Lewis (Distributing Superintendent), of the Newcastle and Gateshead Gas Company, and were informed that great difficulties had been experienced in controlling a pressure-wave system, owing to the intercommunication of the Company's mains, the very wide range of altitudes of the district, the industrial requirements for gas, and the necessity for giving to the city and the large area beyond an adequate supply of gas at all times. It was therefore suggested that, before any mechanical system should be adopted, experiments should be carried out by the Company with the latest improved clock system and the "Bamag" pressure apparatus, in conjunction with an experiment suggested by the Committee.

The following are the Committee's findings: "(1) The possibility to light and extinguish public lamps automatically is established. (2) That this can be accomplished by (*a*) the pressure-wave system, (*b*) the clockwork system, or (*c*) a combination of both systems. (3) That there is a considerable saving with automatic lighting over present-day methods in wages, lamp maintenance, and gas consumption, especially as a system of alternate lighting (say from midnight) is permissible. (4) That the pressure-wave system, centrally controlled, outweighs in advantages any clockwork system. (5) The Alder and Mackay type appears to be at once efficient, simple, and less costly than others seen in actual operation."

The deputation recommend that a trial of 250 Alder and Mackay's controllers be made forthwith. Such an experiment, which would, they say, cover a distinct "section," would enable a concise estimate to be formed of the actual saving to be obtained. The deputation have, however, every confidence in stating that, in their opinion, after paying off the interest and redemption on the capital cost of the automatic apparatus, and allowing a liberal margin for contingencies, there would be a clear saving of from £2000 to £3000 per annum on the present cost for public lighting.

Hunstanton Gas Supply.—At the last meeting of the Gas and Water Committee of the Hunstanton Urban District Council, the Gas Manager (Mr. P. E. Hart) presented his carbonizing statement for the year ended March 31: Coal used, 1500 tons 18 cwt.; gas made, 16,357,000 cubic feet; gas sold and used, 15,479,650 cubic feet; increase in gas made compared with the year 1907-8, 1,738,000 cubic feet; increase in gas sold and used, 1,893,650 cubic feet; average proportion of gas unaccounted for during the year, 5·3 per cent. of the make.

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DUNDEE CORPORATION GAS SUPPLY.

The Corporation of Dundee met as the Gas Commissioners on Wednesday last to consider the accounts of the Gas Department for the year ending April 30, particulars of which were given in the "JOURNAL" for the 1st inst., page 593. Lord Provost Urquhart presided.

There was submitted a supplementary report by the Auditor, in which it was set forth that the amount authorized to be borrowed had been exceeded by £17,068, and that there was in the bank, on current and deposit account, £12,363. The sum required to be set aside for sinking fund was £1000 a year. As the whole amount of £40,000 had now been set aside, it was a question whether further instalments required to be made. He pointed out that no allowance for depreciation had been charged with respect to certain plant. The difference in the original cost of the Dudhope Crescent Electricity Station (to be used as a substation) was stated at £21,983; and of this amount, £5966 had been charged to revenue. No provision had been made for depreciation; and a proportion of certain capital expenditure had been charged to revenue.

Treasurer Soutar moved the adoption of the accounts, which, as previously stated, provided for a reduction in the price of gas by 1d.—making it 2s. 3d. per 1000 cubic feet. The reduction in the rate they might regard as permanent. A suggestion had been made that as the rate diminished, so did the quality of the gas. From all inquiries and the assurances they had received from the responsible officials, however, there seemed to be no substantial ground for this. Underneath the estimates for the current year there were evidences of vim and vitality and progress. For several years it had been under consideration that something should be done by the Department with the view of providing cheap gas for gas-engines. This year proposals had been made for a differential rate, which was equitable alike to the consumers and the Commissioners, and which would have the effect of acting as a feeder and a help to various industries in the city. There was also a proposal to extend the principle which commenced with the introduction of cooking appliances and gas-fires. At a former meeting, Bailie Martin had very properly pointed out that a public department was not expected to enter into cut-throat competition with parties in the trade. The Gas Department, however, had no intention of doing anything of the kind. They had not crossed the border-line in their proposals up till now; and he considered that the proposals relative to gas-fires were eminently fair and reasonable.

Mr. J. Reid, the Convener of the Gas Committee, in seconding, said that in the matter of gas-fires they were not taking the trade from the ironmongers; they were proposing to hire stoves to the great body of ratepayers, who in no circumstances would become purchasers.

Bailie High called attention to their having over-borrowed to the amount of more than £17,000; while they had £12,480 in the bank. They had £7362 on current account, for which they got nothing, and £5000 on deposit receipt, for which they would be getting probably 1 per cent. Why should they over-borrow, paying 3½ per cent., when they had money in the bank?

Treasurer Soutar explained that there was an expectation that they would have to repay a loan; but it had not been called for. This accounted for over £12,000 being in the bank.

The estimates and proposals of the Committee were adopted.

GAS EXHIBITION AT HORNSEY.

As briefly mentioned in the "JOURNAL" last week, an interesting and instructive gas exhibition is being held in the Parish Hall, Edison Road, Crouch End, under the management of the Hornsey Gas Company. The Davis and Richmond Gas-Stove Companies are showing their various makes of gas cookers, grillers, &c.; and cookery lectures, which are well patronized, are given twice daily by Mrs. Godfrey Sutcliff, who in her demonstrations uses alternately the cookers of the above-named makers. An attractive and pleasing exhibit is that of the Bland Light Syndicate, Limited; all the gas-fittings on their stand being of the best make and finish. The Edgar system of high-pressure lighting is the one installed for the illumination of the hall. The power required for driving the compressor is supplied by a small and compact hot-air engine; and the compressor is capable of supplying twelve 300-candle power burners. The whole plant occupies the small floor space of 2 square feet—a fact which has aroused much comment among the visitors. The main hall is lighted by a "Taj" lamp and four No. 16 high-pressure lamps. In the "Taj" lamp is fixed a three-light cluster of brass high-pressure burners, the whole combined giving a powerful diffusive light equal in illuminating power to 1000 candles. The No. 16 lights have one burner each; the candle power of each burner being 600. Mr. Edgar's stand is furnished with a complete collection of gas lighting and heating appliances; one of his most up-to-date introductions being a neat and attractive inverted outdoor lamp called the "Reqs," made for one or three burners. The casings are constructed of copper, and the burners are of the finest cast brass. One of the three-light "Reqs" is utilized for the illumination of the entrance to the hall. "King" and "Eclipse" lamps are also shown. The "Blenheim" gas-fire is still gaining in popularity; and the several parts of which it is composed make this an interesting exhibit. The "Cutmore" greenhouse heater deserves mention. This apparatus has been introduced during the last few months, and has met with much success. The burner chamber is of cast iron, with a heavy copper boiler; while the burner itself is of cast brass, and consumes only from 5 to 7 cubic feet per hour. Other interesting exhibits are the Edgar pattern geysers, the interiors of which are of tinned copper throughout, while the whole of the casing is of heavy polished copper. The valves and fittings on all the patterns are of the finest brass. The most recent type is the Edgar automatic safety geyser. In the event of the water supply failing, the gas is automatically turned off; the pilot-jet only remaining alight. This makes it impossible for the interior to be burnt.

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NOTES FROM SCOTLAND.

From Our Own Correspondent.

Saturday.

The accounts of the Dundee Gas Department for the past year, which were adopted by the Town Council on Wednesday, disclose that the gas sold—875,347,000 cubic feet—was the largest quantity ever sold in any single year, and exceeded the previous year by 49½ millions. The price is now 2s. 3d. per 1000 cubic feet, which is the lowest ever reached in Dundee. During the year, the capital account was increased by £13,610; but the capital per million cubic feet of gas delivered fell from £442 to £433. There is a sinking fund amounting to £11,171. From all points of view the Gas Department in Dundee is, in the words of Treasurer Soutar, in good circumstances. Such a large increase in the consumption of gas, in a year in which decreases have been more experienced, would seem to point to the industrial activity of Dundee having been well maintained.

In the Dunfermline Town Council on Monday, the Gas Committee submitted estimates for the current year, which had been prepared by Mr. A. Waddell, the Engineer and Manager. These showed an anticipated credit balance of £357. The Committee recommended that the prices charged for gas should be the same as last year, with the exception of that for prepayment meter consumption, which is reduced by 1d. Mr. T. Stewart, the Convener of the Committee, in moving approval of the estimates and recommendation, said that the reduction to prepayment meter consumers was an equivalent to the abolition of meter-rents and stove-hires, upon the basis of which the estimates had been prepared. These represented a considerable item in the revenue. The Committee could have reduced the price of gas to the general consumers; but it was thought that the abolition of meter-rents and stove-hires was the better course to adopt. The reductions would apply to Limekilns and Charlestown. If, by reducing the charges, they could increase the consumption of gas, that would be beneficial both to the Corporation and the consumers. The increased make of gas during last year amounted to 9 million cubic feet; there having been a record output of 126 millions. An ample sum had been taken out of revenue to keep the works in first-class condition. At the present time the works were in such a state that, although bad times should come against them, he did not think the community need have any fear of a substantial increase in the price of gas. The recommendations of the Committee were adopted. It was reported that the Gas Committee had withdrawn, meantime, their offer to the Dunfermline District Committee to light Crossgates with gas.

It was reported to the Peebles Town Council on Monday that the quantity of gas made in the year ending May 15 was 36,355,400 cubic feet—a decrease of 322,200 cubic feet upon the previous year.

The first annual general meeting of shareholders of the recently constituted Leven and Methil Gaslight Company, Limited, was held on Monday last. In submitting the balance-sheet, the Chairman—Mr. A. Hogg—said the Directors felt that they could congratulate the Company on the result of the first year's working. They were able to recommend a dividend of 6½ per cent., and to carry forward a substantial sum to the reserve account. The foresight of the Directors, who five or six years ago resolved to extend the supply to Methil, had been justified by the great increase in the gas consumption, which amounted to 36 million cubic feet last year, as compared with 18 millions five years ago. The price of gas had been reduced by 5d. in Leven and 2½d. in Methil.

The Arbroath Town Council on Monday reduced the price of gas by 2½d. per 1000 cubic feet, making it 2s. 8½d., with rebates for gas used in gas-engines of 2½d. per 1000 cubic feet up to 250,000 feet, and of 5d. above that quantity. The price of gas consumed through prepayment meters has now been reduced to 3s. 1½d. The Council considered the report on the gas-works by the Manager—Mr. A. C. Young—which has already been referred to in this column. In speaking to it, Bailie Smith, the Convener of the Gas Committee, said it compared favourably with that of any previous year. The suspense account had been practically cleared off; but it would begin again, on account of the new holder and condensers. For the first time in the history of Arbroath, the price of gas was now as low as 2s. 8½d.

The Directors of the Stirling Gas Company have fixed the prices of gas, as from May 15 last, at: To ordinary consumers, 2s. 6d. per 1000 cubic feet—a reduction of 4d.; for gas-engines, 2s.—a reduction of 4d.; and to prepayment meter consumers, 2s. 10d.—the same as last year.

A statutory meeting of the newly-formed Fauldhouse Gas Company was held on the evening of Monday last—Mr. W. Prentice, the Chairman, presiding. The Chairman reported that 3000 shares of the Company had been issued. The shares were £1 each, and upon each 10s. had been paid; making the receipts £1500. The amount expended upon construction to May 31 was £306. The report of the Directors was adopted, on the motion of Mr. T. Wilson, of Coatbridge, the Engineer to the Company; and the Board of Directors were re-elected.

In the Wishaw Town Council on Monday, Bailie Bell, the Convener of the Gas Committee, referred to the report upon the gas-works by Mr. T. Wilson, of Coatbridge, and moved that the new plant recommended be obtained, but that the ovens remain as they are, while the 9-inch pipe at the gas-works be removed and replaced by a 12-inch one. He also proposed that a Livesey washer be erected, and a further set of pipe condensers; and that two retort-house governors be fitted up. Mr. Loudon moved that eight retorts be placed in each of the larger ovens, and six in the smaller ones, and that they do not expend more money in the meantime on the condensers or retort-house governors. He had no objection to the Livesey washer. He thought the report of the expert justified the position he took up when he was Convener of the Gas Committee. Provost Thomson moved, as a further amendment, that the works be carried on as they were at present, with the exception that the 9-inch pipe might be replaced by a 12-inch one. At the same time he thought that eight retorts should be put into each oven, as they had been before. It was his opinion still that the works had been mismanaged; and he could only accept the expert's report in so far as it coincided with his own experience. If their plant were

APPRECIATIONS.

SERIES No. 4.

From photo. supplied by our Correspondent at Belper.

Mr. Hy. GILLETT, Sanitary Plumber and Hot Water Engineer, BELPER, writes:

May 18, 1909.

"I have used your Richmond No. 100 Model Cooker for nearly 20 years, during which time it has given every satisfaction. It has been a great saving in coal and labour, besides a great convenience. I would not be without it. You may be interested to see a photograph of this Cooker, which must have been one of the first of your make."

We made, 20 years ago, our "Model" Cooker with Removable Burners and parts. All Makers TO-DAY have adopted them. Maintenance has been reduced to a minimum by our up-to-date construction.

THE RICHMOND GAS STOVE & METER CO., LTD.

ADVERTISEMENT OF THE RICHMOND GAS STOVE & METER CO., LTD.
London Offices and Show-Rooms: 182, QUEEN VICTORIA STREET, E.C.
General Offices and Works: WARRINGTON.

sufficient, if properly wrought, there was no reason why they should spend money for new machinery. The motion by Bailie Bell was adopted by six votes to three. The recommendations of the Gas Committee as to coal were adopted.

The output of gas at Broughty Ferry last year was 1,733,000 cubic feet more than in the previous year. The financial results have been most satisfactory, and a substantial credit balance has been assured.

In the Tayport Town Council on Monday, Mr. Allan moved that the Council offer the Ferry-Port-on-Craig Gaslight Company, Limited, £2750 for their undertaking, works, and property, the Company to discharge all debts, subject to details being arranged to the satisfaction of both parties; and that a remit be made to a Committee regarding the matter. The motion was agreed to, Mr. Scott dissenting.

The Inverurie Gaslight Company had an income last year of £1428, and an expenditure of £1047; leaving £381 as profit. Of this sum, £99 has been allowed for depreciation; £146 has been absorbed in paying a dividend of 6½ per cent.; and £136 has been carried forward. The price of gas for cooking and heating has been reduced from 5s. to 4s. 7d. per 1000 cubic feet.

The Dalbeattie Gaslight Company have paid a dividend of 6 per cent., and have reduced the price of gas from 5s. to 4s. 7d. per 1000 cubic feet.

A public meeting, called by the Town Council, was held in Carnoustie on Tuesday evening, to consider the subject of the taking over of the gas undertaking. The Council have offered £16,000; but the Directors of the Gas Company have declined this sum. Although no figure has been mentioned authoritatively, it is understood that the Directors of the Company look upon £23,000 as a fair price. Provost Walker, who presided, stated that the Town Council had engaged an expert, who had gone over the works and everything connected therewith, and had given them his report and the price they should pay. Ex-Provost Soutar considered it was absolutely necessary that they should take over the gas-works, either now or at some future time. He reckoned that the gas consumers in Carnoustie had contributed, in the price of gas, £8000 to £10,000 of the capital in the gas concern; and they did not have a share. Mr. Ferrier suggested that before adopting the Gas Act, they should make one more effort to come to an arrangement with the Directors. He suggested that three members of the Town Council, with three gentlemen nominated by that meeting, should meet in conference with three of the Directors, to see if they could not arrive at a figure which would be satisfactory to all concerned. This course was unanimously adopted; and the nominations were made.

At a meeting of the Largs Town Council this week, intimation was made of an action for damages, in which claims are made for £1500, £1000, and £700 respectively, in respect of gas poisoning, said to have been due to a road-roller breaking gas-pipes in New Street, and the escaping gas getting into the houses. The action has been intimated to the Insurance Company with whom the Corporation have insured their employees and covered third-party risks. It was reported to the Council that two other claims had been settled for £2.

CURRENT SALES OF GAS PRODUCTS.

Sulphate of Ammonia. LIVERPOOL, *June 19.*

Demand has improved as the week has progressed, and, available supplies not being too abundant, there has been a slight improvement in values at all points. The closing quotations are £11 1s. 3d. per ton f.o.b. Hull, £11 3s. 9d. per ton f.o.b. Liverpool, and £11 6s. 3d. to £11 7s. 6d. per ton f.o.b. Leith. For near months small premiums on prompt prices have been paid. For delivery up to the end of the year, buyers' views are hardly above £11 5s. per ton, whereas makers are asking a premium on this price of 2s. 6d. to 5s. per ton, according to port. There is a similar divergence in ideas for delivery over the spring months. Consequently, any business being done abroad is being taken speculatively.

Nitrate of Soda.

There has been a substantial decline in values on the Continent, but, local supplies being strongly held, spot prices are maintained at 10s. 4½d. per cwt. for 95 per cent., and 10s. 7½d. for refined quality.

Tar Products. LONDON, *June 21.*

The markets for tar products have been firm throughout the past week, with the exception of carbolic acid, in which article business appears to be impossible at the present moment. Apparently the rise which took place a little while ago was entirely speculative; and as it received no support whatever from the manufacturers, the price has gone back to the level of about 1s. for 60's. Pitch is very firm; and though no business is reported, prices are certainly as strong as ever. But owing to the fact that manufacturers are fairly well sold, and there is no desire on the part of Continental buyers to purchase, it is doubtful whether any considerable business will be done for the next few weeks. Benzol 90 per cent. is steadier; and for prompt delivery a fair price is reported to have been paid. Fifty-ninety per cent. benzol is also slightly improved; but toluol remains unchanged. Solvent naphtha is decidedly easier, especially in the North. Heavy naphtha is quiet, and there is not very much business in this article. Creosote is steady, and the majority of manufacturers appear to be fairly well sold. Refined naphthalene is quiet; but salts maintain their price.

The average values during the week were: Tar, 14s. 6d. to 18s. 6d., *ex* works. Pitch, London, 27s. 6d. to 28s.; east coast, 27s. to 27s. 6d.; west coast, 26s. 6d. to 27s. 6d. f.a.s. Mersey ports, 26s. to 27s. f.o.b. others. Benzol, 90 per cent., casks included, London, 6d. to 6½d.; North, 5¾d. to 6d.; 50-90 per cent., casks included, London, 6¾d. to 7d.; North, 6d. to 6½d. Toluol, casks included, London, 8½d. to 8¾d.; North, 7¾d. to 8d. Crude naphtha, in bulk, London, 3½d. to 3¾d.; North, 2¾d. to 3d.; solvent naphtha, casks included, London, 11d. to 11½d.; North, 9½d. to 10d.; heavy naphtha, casks included, London, 10¾d. to 11d.; North, 9¾d. to 10d. Creosote, in bulk, London, 2¾d. to 2 13/16d.;

SAWER & PURVES,

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Prepayment Meters,
Ordinary Meters,
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Main Taps,
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North, 2½d. to 2⅝d. Heavy oils, in bulk, 2⅝d. to 3d. Carbolic acid, 60 per cent., casks included, east coast, 11½d. to 1s., west coast 11d. to 11½d. Naphthalene, £4 10s. to £8 10s.; salts, 37s. 6d. to 40s., packages included and f.o.b. Anthracene, "A" quality, 1½d. to 1⅝d. per unit, packages included and delivered.

Sulphate of Ammonia.

The market has been steady throughout the past week, and prices have hardened slightly all round. It is reported that Japan is again a buyer; and should she come into the market to any extent, it is bound to improve the prospects for this article. London Gas Companies still quote £11 10s.; but it is possible to buy outside makes on Beckton terms at £11 to £11 1s. 3d. In Hull, business has been done at £11 2s. 6d., and in Liverpool at £11 3s. 9d. In Leith, business is reported at £11 6s. 3d.; and the majority of manufacturers are now asking £11 7s. 6d. for prompt, and £11 10s. for forward.

COAL TRADE REPORTS.

Northern Coal Trade.

The coal trade has felt the influence of the unrest among miners. There has been a pressure to get coal away for this reason, and also because the great Tyneside holidays this week will lessen the output in some measure. Prices have varied a little, but perhaps less than might have been expected. Best Northumbrian steam coals are from about 12s. to 12s. 3d. per ton f.o.b., second-class steams from 10s. 9d., and steam smalls from 5s. 3d. to 6s. 3d.; but the prices may change when the decision of the Welsh miners is made known. In the gas coal trade, the demand is full for the season, and the output appears to be well taken up. The prices of Durham gas coals vary from about 10s. to 11s. f.o.b., according to quality, for the usual classes; and up to 11s. 6d. for "Wear specials." The markets are generally firm, with rather heavy exports. As to contracts, a few small lots have been sold for some of the ports of the Mediterranean, at prices that should leave something like the current values at the pit. The Brussels gas coal contract has been divided—foreign collieries obtaining a large part of the order, and the rest (some 9000 tons) going to Yorkshire, owing to the higher prices of Durham. There is a firm market for coke. Gas coke is not much altered, though the output is low. Good gas coke is from 12s. 9d. to 13s. per ton f.o.b. in the Tyne or Wear.

Scotch Coal Trade.

Business is restricted, and prices are firmer all round. There is still a belief among consumers that an agreement will be come to between the coalmasters and the miners as to wages, and consequently there is no greatly increased demand. On the other hand, coalmasters are practically declining to sell for forward delivery. The prices quoted are: Ell 9s. 6d., splint 9s. 6d. to 10s., and steam 9s. 6d. per ton f.o.b. Glasgow. The shipments for the week amounted to 321,915 tons—a decrease of 15,365 tons upon the preceding week, but an increase of 37,953 tons upon the corresponding week of last year. For the year to date, the total shipments have been 6,338,066 tons—an increase of 456,470 tons upon the corresponding period.

Coventry Gas Workers Pension Scheme.

The reconsidered scheme of the Gas Committee of the Coventry Corporation for the establishment of pensions for displaced employees of the Gas Department, consequent upon the abandonment of the old works on the removal to the new buildings at Foleshill, came before the Town Council at their last meeting. The Chairman of the Committee (Mr. Councillor Batchelor), though proposing the adoption of the amended scheme—with its reduction of 2s. per man on the original scale—confessed that he was more in agreement with the more liberal payment; but the Council having asked the Committee to reconsider the whole matter, it was felt that it would be useless to bring up the same scale again. Mr. Bannington moved an amendment, rejecting the lower scale in favour of the old one. He urged that this would only mean an increase of about £60 in the total cost. He compared this with the expenditure of between £60 and £70 on the production of a souvenir of the opening of the new gas-works—an expense that Mr. Cash described as lavish and unnecessary. Incidentally, the last speaker referred to the cost of the new works, and said, in his view, the scheme was far in excess of requirements. Alderman Drinkwater said that, as one who voted for the matter being referred back (mainly on the ground that it might have been possible to retain the services of these men), he was now prepared to vote for the higher scale. The Council, on a division, adopted the Committee's original proposal, which allows of payments from 8s. to 14s. a week according to length of service.

Middleton Gas Undertaking.—In a paragraph which appeared in the last number of the "JOURNAL," it was stated that there had been a falling off in the profits of the gas-works in the past financial year. It appears that the gross revenue was £23,517, and the gross expenditure £15,593; leaving a gross profit of £7924, against £8880 before—a decrease of £956. The net profit was £1651, against £2460—a decrease of £809 10s. 11d. The reduced profit, says Mr. C. F. Broadbent, the Gas Engineer and Manager, is due to a combination of circumstances. While the price of coal has reached a very high figure, the losses due to the reduced consumption, and the low prices obtained for residuals through bad trade, have been severe. Excellent working results were maintained throughout the year, and repairs and extensions of plant, which are urgently needed, are being pushed on as rapidly as possible. The quantity of gas sold was 117,190,100 cubic feet—a decrease of 4,432,400 cubic feet, or 3·64 per cent., compared with the previous year. The consumption in mills, &c., fell 11·88 per cent. The leakage amounted to 9,848,300 cubic feet, or 7·61 per cent., against 6·12 per cent. in 1907-8. This is said to be chiefly accounted for by the increase in heavy motor traffic; roads not being constructed nor gas-mains laid to stand the excessive weight now carried.

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ARE STOVES
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Landlords' Liability for Water-Rent.

The Crediton District Council were plaintiffs in an action tried at the Crediton County Court last Tuesday, in which James Buckingham, the owner of certain cottage property, was sued for £1 9s. owing in respect of water-rents for the property. Defendant said the water-rent had been levied for fifteen years; but he had never paid it. It had always been paid by his tenants, who had the benefit of the water; and he did not consider he was liable. The tenants had, as a matter of fact, tendered the money; but the collector had refused to accept it. The collector explained that the money was not tendered until after the issue of the summons. His Honour Judge Lush Wilson, in giving judgment for the District Council, said that if the tenants were liable to pay the water-rent, then the landlord was also liable. If the tenants chose to pay the rent, and if the District Council chose to accept it in discharge, that was a matter for those concerned. But the Council clearly had the statutory right to come down upon the landlord; and they were not bound to accept payment from the tenants.

A Water Board's Heavy Loss.—The Heywood and Middleton Water Board last Thursday reported a loss on the past year's working of £11,027. The deficiency for the previous year was £5007; and it was explained that the increased loss this year was due to a full year's interest having been charged on the Ashworth Moor new reservoir, which has cost £239,915 exclusive of £3796 for plant. The Board "without pleasure, but with feelings of regret," ordered precepts to be make on the Heywood and Middleton Corporations for sums of £5692 and £5335 respectively, to meet the deficiency.

Sale of Bristol Gas Stock.—Last Thursday, Mr. Nichols (Messrs. Geo. Nichols, Howes, Young, Alder, and Co.) offered for sale, in accordance with the recent announcement in our advertisement columns, £25,000 of 5 per cent. general capital stock and £10,000 of 4 per cent. new debenture stock of the Bristol Gas Company. The former realized prices ranging from £117 5s. down to £114 5s. (the reserve being £113); the entire issue bringing in £28,765 10s., or an average of £115 1s. 2d. per £100. The debentures fetched an average of £101 12s. 11d. (the reserve being £100); and they produced £10,164 15s.

New Joint-Stock Companies.—The Syva Indestructible Mantle Company, Limited, has been registered with a capital of £60,000, in £1 shares, to carry on the business of incandescent mantle manufacturers, gas-burner makers, &c. The Syva Mantle Syndicate, Limited, consent to the registration. The offices are at Suffolk House, Cannon Street, E.C. The Mazza Centrifugal Gas Syndicate, Limited, has been registered with a capital of £35,000, in £1 shares, to adopt an agreement between Edoardo Natale Mazza and H. A. Bourich; to acquire any invention or machinery in connection with the separation of air, or any other gaseous mixtures, compounds, liquids, and other bye-products and processes; to develop and turn them to account; and to carry on the business of founders, engineers, millwrights, machinists, wheelwrights, &c. One of the first Directors is Mr. C. B. Tully. Among other registrations during the past week are the Golden Gleam Mantle Syndicate, with a capital of £10,000, in £1 shares; and the United Tar and Chemical Company, with a capital of £10,500, in 10,000 preferred shares of £1 each and 10,000 deferred shares of 1s. each.

Birmingham Gas Department Figures.—We have received from Mr. Thomas H. Clare, the City Treasurer of Birmingham, a copy of the detailed accounts prepared by him for the twelve months to March 31. Those relating to the Gas Department furnish some figures in addition to what were given in the "JOURNAL" for May 4 (p. 320). The revenue account shows a balance of income in excess of expenditure of £190,302 for 1908-9, carried to profit and loss account. After providing for annuities, interest, and redemption of debt, the balance of the profit and loss account was £71,459. The amount of capital expended during the year was £25,511; and the value of buildings and plant abandoned, &c., was £59,041. The total expenditure on capital account to March 31, 1909, was £2,476,325. The amount of the reserve fund provided out of revenue, with accumulations, was £100,000; while the gross total of loans negotiated, including annuities, was £2,908,949. The amount provided from revenue for redemption of debt during 1908-9 was £45,375; and the gross amount provided for redemption of debt to the end of the year was £882 567. The balance of loans remaining to be provided for was £2,026,382.

Explosions in Bermondsey.—A report was presented at the meeting of the Bermondsey Borough Council last Tuesday on two explosions which have recently occurred in the district. These accidents, following upon the serious explosion towards the close of last year in Grange Road, which caused two deaths, have created a feeling of uneasiness among the inhabitants. In his report, the Borough Engineer says: "It was reported to the General Purposes Committee on April 21 that there had been an explosion in Long Lane, which was supposed to be due to the overcharge of the London County Council's sewer. The effect was to blow up the footpath and to disturb about 54 square feet of York paving. The explosion was accompanied by a loud report, which caused much alarm to the tenants of the neighbourhood. At the same time a very large quantity of water was emitted from the opening. A letter of complaint was sent to the Chief Engineer of the London County Council; but no reply was received. Again, on the morning of May 25, another explosion occurred at the same place, presumably from the same cause. This second occurrence caused considerable excitement among the residents, and has rendered them in a state of fear of possible consequences that might arise to passers-by; and it is suggested that a strong letter of complaint should be sent to the Main Drainage Committee of the Council, calling upon them to take such measures as will prevent the recurrence of like accidents. On this second occurrence, about 100 square feet of paving were blown up, and the post-office box was disturbed; and since the Borough Council have their electric main close by, there is imminent danger of serious consequences to the installation taking place."

"CANNON"

Imperial Exhibition,

Shepherd's Bush, W.

SMOKE ABATEMENT.

See the REPORT of the

COAL SMOKE ABATEMENT SOCIETY

17th November, 1906.

The following is from Table II. of the Report giving Particulars regarding Eight of the Best Gas-Fires tested.

	MAKER AND STOVE.
1.	CANNON CO.'S "IRIS"
2.	"A"
3.	CANNON CO.'S "VICTORY" (LARGE)
4.	"B"
5.	"C"
6.	"D"
7.	"E"
8.	"F"

See columns for details in full report in "Lancet," 17th November, 1906, page 1366, and "Journal of Gas Lighting," 20th November, 1906, page 540.

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Exmouth Water Supply.—After a fortnight's continuous pumping, the operations at the Dotton borehole in connection with the proposed augmentation of the water supply of Exmouth have been suspended. The results of this test have been most satisfactory. An average yield of about 45,000 gallons per hour, or more than a million gallons per day, has been obtained; and there is no indication that the abundance of the supply has been in any way affected. Mr. Hill, the Engineer, who visited the works last week, expressed himself as thoroughly satisfied in every way; and there appears to be no doubt that the people of Exmouth have now the means of settling in a definite way the question of the water supply for a very long time to come. The present supply is about 300,000 gallons a day; so that the Dotton well will yield sufficient water for a much greater population than is now to be served. It is expected that the necessary steps will be taken to promote again next session the Bill which an adverse vote of the ratepayers prevented the District Council from proceeding with this year.

A Cornish Village Water Supply.—An inquiry was held at Polruan, a Cornish fishing village, last Tuesday, by Mr. H. A. Reed, a Local Government Board Inspector, respecting the water supply. It transpired that for many years this was vested in feoffees, but that at the Diamond Jubilee of Queen Victoria they made a gift of it to the village. Since then it has been managed by the local landowners, who have connected the houses of all persons willing to pay the local rate. Both the supply and the management were said to have given complete satisfaction to all the villagers except two, and these, after failing to induce the District Council to acquire the water supply, moved the Local Government Board to take action. The Clerk to the District Council admitted that the position was anomalous and irregular; but he pleaded that it was what the people liked, and that the landowners had acted with the sole desire to benefit the village. The fact that the inhabitants are satisfied with the existing state of things was emphasized at the close of the inquiry by a hostile demonstration against one of the persons who had made complaint.

Petersfield Water Supply.—At the meeting of the Petersfield Urban District Council last Tuesday, the Chairman (Mr. W. C. Burley) stated that, as the result of considerable negotiation, Mr. Charles W. Seward, a member of the Council, obtained the option to purchase Oakshott Farm, Hawkley, the property of Sir Jonathan Hutchinson, on which there is an abundant water supply of excellent quality. Mr. H. W. Taylor, the Engineer of the Liss Water-Works, was employed to test the springs, and reported that without tunnelling they would produce 150,000 gallons per day. The springs are sufficiently high to enable the water to be brought into the Council's present reservoir by gravitation, and thus save all the expense of pumping. The purity of the water is undoubted, and it would not require filtration. The site is about 138 acres, including 50 acres of hop land, farmhouse and buildings, and five cottages. The purchase-money was £5100. Mr. W. G. Nicholson, M.P., had very kindly consented to provide the money at the low rate of 3¾ per cent. until the scheme was sanctioned by the Local Government Board. At a previous meeting, it was decided to purchase the site, and a cheque was drawn for the deposit.

Water Supply of Saltash.—Mr. H. A. Reed held an inquiry at Saltash last Wednesday, on behalf of the Local Government Board, with reference to an application by the Town Council for power to borrow £2100 for works of water supply. Mr. F. E. Cleverton, the Town Clerk, explained that the water was obtained from the Plymouth Corporation, and had been conveyed across the River Tamar by a 5-inch steel pipe laid in the bed of the river. During the past five years, the pipe had burst three times in the river; and there had been eight instances of its bursting on the foreshore. This had caused much inconvenience, and the cost of the repairs—especially those which had to be done under water—was considerable. An agreement had accordingly been made with the Great Western Railway Company for carrying the water-main across the Royal Albert Railway Bridge. Mr. H. Bulteel, the Engineer for the scheme, said the new pipes had been laid and tested, and it was found that they gave very satisfactory results.

Experimental High-Power Lighting at the Chichester Railway Station.—An interesting experiment is being carried out, by the courtesy of the Railway Company, in high-power lighting at the Chichester Station. The new lighting is by gas compressed to from 8 to 10 inches of water; the compressor used being by the Scott-Snell Vacuum Gas Compressor, Limited, of Westminster. The two large burners at the railway bridge are by the James Keith and Blackman Company, Limited, and are of 600-candle power each; the other pair being by Messrs. George Bray and Co., Limited, and of about 300-candle power each. The installation is a tentative one, and has been put up by the Chichester Gas Company, under the supervision of Mr. T. E. Pye, the Engineer and Manager, to ascertain the capabilities of the system as applied to combination lighting of both large and small units. The efficiency per cubic foot of gas burned is stated to be very high; and from the work so far done the cost promises to be about 1¼d. per 1000 candle power inclusive.

Halifax Reservoirs Claims Settled.—An important meeting of the Halifax Town Council was held last Wednesday, to consider a proposed settlement between the Corporation and the Executors of Mr. Enoch Tempest, the Contractor for the Walshaw Dean Reservoirs. The Water Committee advanced Mr. Tempest, during the construction of the reservoirs, about £23,000, which has not been repaid. On their part, the Executors preferred a claim for £80,000, alleged to be due for different works carried out beyond the contract. Extra works, it was admitted, had been executed in connection with the removal of additional peat from the beds of the reservoirs, and in the introduction of extended "beaching" on the sides; but it was claimed that all had been paid for on a schedule of prices previously arranged. It was stated that a settlement had been effected, under which the claim for £80,000 was to be abandoned, and the Corporation were to forego their claim for the £23,000 advanced. The Council passed a resolution agreeing to this. The original estimate of the cost of the reservoirs was about £170,000; but the outlay actually made upon them exceeds £300,000.

GAS COMPANIES' STOCK AND SHARE LIST.

Referred to on p. 804.

Issue	Share.	When ex-Dividend.	Dividend or Dividend & Bonus	NAME.	Closing Prices.	Rise or Fall in Wk.	Yield upon Investment.
£			p.c.				£ s. d.
590,000	10	Apl. 16	10	Alliance & Dublin 10 p.c.	17½—18	..	5 11 1
298,955	10	,,	7	Do. 7 p.c.	12½—13	..	5 7 8
310,000	Stk.	Jan. 14	4	Do. 4 p.c. Deb.	9⅝—100	..	4 0 0
200,000	5	May 27	6¼	Bombay, Ltd.	5¼—5⅝	..	5 12 7
40,000	5	,,	6¼	Do. New, £4 paid	4⅜—4⅝	..	5 18 10
50,000	10	Feb. 25	14	Bourne- mouth Gas and Water — 10 p.c.	28⅜—29½	..	4 15 9
51,810	10	,,	7	Do. B 7 p.c.	16¾—17	..	4 2 4
53,200	10	,,	6	Do. Pref. 6 p.c.	15⅜—15⅝	..	3 15 7
380,000	Stk.	,,	12½	Brentford Consolidated	252—255	+2½	4 18 1
300,000	,,	,,	9¾	Do. New	194—196	+1	4 16 11
50,000	,,		5	Do. 5 p.c. Pref.	122—124	..	4 0 8
206,250	,,	June 11	4	Do. 4 p.c. Deb.	100—102*	+1	3 18 5
220,000	Stk	Mar. 12	10⅝	Brighton & Hove Orig.	212—214	..	5 0 6
246,320	,,	,,	7½	Do. A Ord. Stk.	154—156	..	4 19 4
460,000	20	Apl. 16	10	British	42¾—43¼	..	4 12 6
109,000	Stk.	Feb. 25	6	Bromley, A 5 p.c.	119—121	..	4 19 2
165,700	,,	,,	4¾	Do. B 3⅞ p.c.	89—91	..	4 18 11
82,278	,,	,,	5¾	Do. C 5 p.c.	108—110	..	5 0 0
51,000	,,	Dec. 30	3½	Do. 3½ p.c. Deb.	89—91	..	3 16 11
500,000	10	May 13	7	Buenos Ayres (New) Ltd.	13¾—14¼	..	4 18 3
250,000	Stk.	Dec. 11	4	Do. 4 p.c. Deb.	94—96	..	4 3 4
100,000	10	—	—	Cape Town & Dis.. Ltd.	4—5	..	—
100,000	10	—	—	Do. 4½ p.c. Pref.	5¾—6	..	—
50,000	50	May 3	6	Do. 6 p.c. 1st Mort.	48—49	..	6 2 5
100,000	Stk.	Dec. 30	4½	Do. 4½ p.c. Deb. Stk.	80—82	+2	5 9 9
157 150	Stk.	Feb. 25	5	Chester 5 p.c. Ord.	109—111	..	4 10 1
1,493,280	Stk.	Mar. 12	5⅛	Commercial 4 p.c. Stk.	108—110	..	4 14 6
560,000	,,	,,	5	Do. 3½ p.c. do.	103—105	..	4 15 3
475,000	..	June 11	3	Do. 3 p.c. Deb. Stk.	81—83*	..	3 12 3
800,000	Stk.	,,	5	Continental Union, Ltd.	96—98*	..	5 2 0
200,000	,,	,,	7	Do. 7 p.c. Pref.	135—137*	..	5 2 2
492,270	Stk.	—	5	Derby Con. Stk.	121—123	..	4 1 4
55,000	,,	—	4	Do. Deb. Stk.	103—105	..	3 16 2
148,995	,,	Mar. 31	5	East Hull 5 p.c. Ord.	100—102	..	4 18 0
486,090	10	Jan. 28	12	European, Ltd.	24⅞—24⅞	+⅛	4 17 0
354,060	10	,,	12	Do. £7 10s. paid.	18¼—18⅝	+⅛	4 16 0
15,161,545	Stk.	Feb. 11	4/10/8	Gas light and Coke — 4 p.c. Ord.	103—104	..	4 7 0
2,600,000	,,	,,	3⅜	Do. 3½ p.c. max.	88—89	..	3 18 8
3,799,735	,,	..	4	Do. 4 p.c. Con. Pref.	105—107	..	3 14 9
4,193,975	..	June 11	3	Do. 3 p.c. Con. Deb.	84—85*	..	3 10 7
258,740	Stk.	Mar. 12	¾	Hastings & St. L. 3½ p.c.	93—95	..	5 0 0
82,500	,,	,,	6¼	Do. do. 5 p.c.	118—120	..	5 4 2
70,000	10	Apl 29	11	Hongkong & China, Ltd.	17⅞—18	..	6 2 3
1,123,500	Stk.	Mar. 12	6½	Ilford A and C	140 —142	+2	4 11 7
65,783	,,	,,	5	Do. B	106—108	+1	4 12 7
63,000	,,	Dec. 30	4	Do. 4 p.c. Deb.	102 —104	..	3 16 11
4,940,000	Stk.	May 13	8	Imperial Continental	179—181	..	4 8 5
473,600	Stk.	Feb. 11	3½	Do. 3½ p.c. Deb. Red.	95—97	..	3 12 2

Issue.	Share.	When ex-Dividend.	Dividend or Dividend & Bonus	NAME.	Closing Prices.	Rise or Fall in Wk.	Yield upon Investment.
£			p.c.				£ s. d.
195,242	Stk.	Mar. 12	6	Lea Bridge Ord. 5 p.c.	120—122	..	4 18 4
561,000	Stk.	Feb. 25	10	Liverpool United A	226—228	+1	4 7 9
718,100	,,	,,	7	Do. B	168—170	..	4 2 4
306 083	,,	Dec. 30	4	Do. Deb. Stk.	105—107	..	3 14 9
75,000	5	June 11	6	Malta & Mediterranean	4⅜—4⅝*	..	6 3 1
550,000	100	Apl. 1	5	Met of 5 p.c. Deb.	100—102	..	4 18 0
250,000	100	,,	4½	Melbourne 4½ p.c. Deb.	101—103	..	4 7 5
541,920	20	May 27	3⅜	Monte Video Ltd.	12⅜—13	..	5 7 8
1,775,892	Stk.	Feb. 25	4½	Newc't e & G't sa'd Con.	106⅜—107½	..	4 3 9
318,795	Stk	Dec. 30	3⅜	Do. 3½ p.c. Deb.	92—94	+1	3 14 6
15,000	10	Feb. 25	10	North Middlesex 10 p.c.	19½—20	..	5 0 0
55,940	10	,,	7	Do. 7 p c	13—13⅜	..	5 3 8
300,000	Stk.	Apl. 29	8	Oriental, Ltd.	137—139	..	5 15 1
60,000	5	Mar. 31	8	Ottoman, Ltd.	6—6¼	..	6 8 0
31,800	53	Feb. 25	13	Portsea Island A.	137—139	..	4 19 0
60,000	50	,,	13	Do, B.	129—131	..	4 19 3
100,000	50	,,	12	Do. C.	119—121	..	4 19 2
114,800	50	,,	10	Do. D and E.	101—103	..	4 17 1
398,490	5	May 13	7	Primitiva Ord.	6⅞—7	..	5 0 0
795,083	5	Jan. 28	5	Do. 5 p.c. Pref.	5¼—5⅜	..	4 10 11
481,903	100	June 1	4	Do. 4 p.c. Deb.	94—96	..	4 3 4
1, 60,000	10	Apl. 29	8	River Plate Ord.	14⅜—15½	..	5 4 11
312,650	Stk.	Dec. 30	4	Do. 4 p.c. Deb.	95—97	..	4 2 6
250,000	10	Mar. 31	8	San Paulo, Ltd.	13⅜—14½	..	5 12 3
62,500	10	,,	6	Do. 6 p.c. Pref.	11½—12¾	..	4 18 0
125,030	50	Jan. 2	5	Do. 5 p.c. Deb.	50⅜—51⅜	..	4 17 1
135,000	Stk	Mar. 12	10	Sheffield A	236—238	..	4 4 0
209,984	,,	,,	10	Do. B	233—235	..	4 5 1
523,500	,,	,,	10	Do. C	234—236	..	4 4 9
70,000	10	June 11	10	South African	13⅜—14*	..	7 2 10
6,429,895	Stk.	Feb 11	5/6/8	South Met., 4 p.c. Ord.	122—124	..	4 6 0
1,895,445	,,	Jan 14	3	Do. 3 p.c. Deb.	85—86	..	3 9 9
209,820	Stk.	Mar. 12	8	South Shields Con. Stk.	152—154	..	5 3 11
605,000	Stk.	Feb. 25	5⅛	S'th Suburb'n Ord. 5 p.c.	120—122	..	4 10 2
60,000	,,	,,	5	Do. 5 p.c. Pref.	122—124	..	4 0 8
117,058	,,	Jan. 14	5	Do. 5 p.c. Deb. Stk.	124—126	..	3 19 4
502,310	Stk.	May 13	5	Southampton Ord.	110—112	..	4 9 3
120,000	Stk.	Feb. 25	6⅜	Tottenham A 5 p.c.	132—134	..	5 0 9
423,940	,,	,,	5¼	and B 3⅜ p.c.	111—113	..	4 12 11
149,470	,,	Dec. 30	4	Edmonton 4 p.c. Deb.	101—103	..	3 17 8
182,380	10	June 11	8	Tuscan, Ltd.	9—9⅛*	+⅛	8 8 6
149,900	10	Jan.	5	Do. 5 p.c. Deb. Red.	101—103	..	4 17 1
236,476	Stk.	Feb. 25	5	Tynemouth, 5 p.c. max.	109—111	+4	4 10 1
255,636	Stk.	Feb. 25	6½	Wands- B 3½ p.c.	139—141	..	4 12 2
79,416	,,	Dec. 30	3	worth 3 p.c. Deb. Stk.	73—75	..	4 1 1
835,872	,,	Feb. 25	5½	West Ham 5 p.c. Ord.	121—123	..	4 5 4
210,000	,	,,	5	Do. 5 p.c. Pref.	126—128	+1	3 18 2
253,300	,,	Dec. 30	4	Do. 4 p.c. Deb. Stk.	107—109	..	3 13 5

Prices marked * are "Ex div."

Public Lighting of Marylebone.—At the meeting of the Marylebone Borough Council last Thursday, the Lighting Committee reported that they had considered a letter from the Gaslight and Coke Company, stating that they were prepared to contract for the lighting of the 35-8 gas-lamps at present in use in the borough, and for their maintenance in the highest state of lighting efficiency on the following terms: (1) A contract to be entered into for a period of three years from the 1st prox., and thereafter until terminated by six months' notice from either party, to include the whole of the street-lamps at present lighted by gas in the borough; the Council to have the right to increase or decrease the number at any time within the contract period for any purpose other than the substitution of another illuminant. (2) The Company to supply gas to, light, extinguish, clean, paint two coats annually, repair, and maintain in thoroughly efficient lighting order, the lamps at the following rates of charge: Lamp containing one burner consuming 4 cubic feet per hour, £3 1s. 7d. per annum; 4½ cubic feet, £3 4s.; 4½ cubic feet and bye-pass, £3 7s. 10d. Lamp containing two burners consuming 8½ cubic feet per hour, £5 10s.; 8½ cubic feet and bye-pass, £5 17s. 9d. Lamp containing three burners consuming 12¾ cubic feet per hour, £8 3s. 6d.; 12¾ feet to 1 a.m. only, £6 1s. At these prices, the gas-lamps would cost the Council £14,120 per annum—a saving of more than £860 per annum compared with what the Company understand to be the present total cost.

On Tuesday last eleven shares of £5 each, and forty shares of £10 each, of the Coatbridge Gas Company were exposed for sale; and the prices realized were £12 10s. and £17 10s. respectively.

The Swansea Town Council have accepted Messrs. John Aird and Sons' tender for constructing a second line of pipes to the Cray Water-Works, amounting to £99,738 in value. The undertaking has already cost the town half-a-million sterling.

At the last meeting of the Directors of the Reading Gas Company, tenders for £5000 of 4 per cent. perpetual debenture stock were opened, and allotments made. The tenders amounted to over £12,000; and the average price realized was 104¼ per cent.

At the Armoury, Stockport, yesterday evening, an exhibition of gas appliances, comprising samples from all the leading stove makers, was opened under the auspices of the Gas Department, and will be continued till Friday; cookery lectures being delivered twice daily by Miss Crichton.

The Directors of the European Gas Company, Limited, have decided to recommend the payment of the same dividend and bonus as last year—viz., 10s. per share on the fully-paid shares, and 7s. 6d. on those on which £7 10s. has been paid; and a bonus of 2 per cent. on all shares, according to the amount paid thereon.

WANTED, FOR SALE, CONTRACT, &c., ADVERTISEMENTS IN THIS WEEK'S "JOURNAL."

Situations, &c., Vacant.

DRAUGHTSMAN. No. 5107.
AGENTS. Julius Norden, 44, Farringdon Street, E.C.
IMPROVER TO GAS-FITTING. No. 5110.

Situations Wanted.

ENGINEER AND MANAGER OR ASSISTANT. No. 5104.
FITTER OR FOREMAN FITTER. No. 5108.
SECRETARY, MANAGER, OR ACCOUNTANT. W. B. Mimmack, St. Paul's Cray.
SLOT COLLECTOR AND CLERK. No. 5109.
SULPHATE LEADWORK. Leadburner, 117, Gallaway Road, Shepherd's Bush.

Correspondence Classes.

CORRESPONDENCE COLLEGE COMPANY. Department B., Cambridge.

Patent Licences.

EXTRACTION OF AMMONIA FROM DISTILLATION GASES. Haseltine, Lake, and Co., Chancery Lane, W.C.

Plant, &c. (Second-Hand), for Sale.

ASCENSION PIPES, &c., CONDENSERS, PURIFIERS, GOVERNOR, ENGINE AND EXHAUSTERS, WEIGHBRIDGE, &c. Draycott Gas Company.
EXHAUSTERS, &c. Stirling Gaslight Company. Tenders by June 30.
GAS-WORKS PLANT. Long Eaton Gas Company.
PURIFIERS, &c. Sutton Gas Company.
STATION METER. T. G. Marsh, Manchester.
"JOURNAL" VOLUMES. Gregory, Wealdstone.

TENDERS FOR

Coal and Cannel.

ACCRINGTON GAS AND WATER BOARD. Tenders by July 6.
KESWICK GAS COMPANY. Tenders by June 23.
MANSFIELD GAS DEPARTMENT. Tenders by June 19.
PONTYPRIDD URBAN DISTRICT COUNCIL. Tenders by June 28.
RADCLIFFE AND PILKINGTON GAS COMPANY. Tenders by June 29.
STRETFORD GAS COMPANY. July 10.

Cookers.

PONTYPRIDD GAS DEPARTMENT. Tenders by June 28.

Fire-Clay Goods.

PONTYPRIDD GAS DEPARTMENT. Tenders by June 28.

General Stores (Lead, &c., Tubing, Barrows and Rake Heads, Oils, Tallow, Paints, Sulphuric Acid, Gaskin, &c., Brushes, Rubber Tubing, &c., Timber, Castings, Iron and Steel).

PONTYPRIDD GAS DEPARTMENT. Tenders by June 28.
SALFORD GAS DEPARTMENT. Tenders by July 1.

Incandescent Materials.

PONTYPRIDD GAS DEPARTMENT. Tenders by June 28.

Lamps and Copper, Pendants, Brass Fittings and Sundries, Slot Fittings, &c., Main Taps, and Locks.

PONTYPRIDD GAS DEPARTMENT. Tenders by June 28.
SALFORD GAS DEPARTMENT. Tenders by July 1.

Lime.

MANSFIELD GAS DEPARTMENT. Tenders by June 19.

Meters.

PONTYPRIDD GAS DEPARTMENT. Tenders by June 28.
SALFORD GAS DEPARTMENT. Tenders by July 1.

Oil for Gas Manufacture.

MANCHESTER GAS DEPARTMENT. Tenders by July 1.
PONTYPRIDD GAS DEPARTMENT. Tenders by June 28.

Pipes, &c.

PONTYPRIDD GAS DEPARTMENT. Tenders by June 28.
SALFORD GAS DEPARTMENT. Tenders by July 1.

Retort-House Governors.

WISHAW GAS DEPARTMENT. Tenders by June 30.

Tar and Liquor.

CANTERBURY GAS AND WATER COMPANY. Tenders by June 26.
KESWICK GAS COMPANY. Tenders by June 23.
MANSFIELD GAS DEPARTMENT. Tenders by June 19.
PONTYPRIDD GAS DEPARTMENT. Tenders by June 28.

Washer and Condensers.

WISHAW GAS DEPARTMENT. Tenders by June 30.

NOTICES TO CORRESPONDENTS, ADVERTISERS, AND SUBSCRIBERS.

No notice can be taken of anonymous communications. Whatever is intended for insertion in the "JOURNAL" must be authenticated by the name and address of the writer; not necessarily for publication, but as a proof of good faith.

COPY FOR ADVERTISEMENTS for the "JOURNAL" should be received at the Office NOT LATER than TWELVE O'CLOCK NOON ON MONDAY, to ensure insertion in the following day's issue.

Orders for Alterations in, or stoppages of, PERMANENT ADVERTISEMENTS should be received by the FIRST POST on SATURDAY.

Wanted, For Sale, and Tender Advertisements, Six Lines and under, 3s.; each additional Line, 6d.

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"VOLCANIC" FIRE CEMENT.
Resists 4500° Fahr. Best for GAS-WORKS.
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WET AND DRY GAS-METERS, PREPAYMENT METERS, STATION METERS, AND GOVERNORS.
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SPECIALLY prepared for the Manufacture of SULPHATE OF AMMONIA.
SPENCER CHAPMAN & MESSEL, LTD.,
with which is amalgamated WM. PEARCE & SONS, LTD.
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Telegrams: "HYDROCHLORIC, LONDON."
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ROBERT DEMPSTER & SONS, Ltd.,
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LUX'S GAS PURIFYING MASS.
See Advertisement on p. 759.
Friedrich Lux, Ludwigshafen-am-Rhein.

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Correspondence invited.

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CHAIN BELT ENGINEERING CO.
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FOR REALLY HIGH-CLASS
ELEVATORS AND CONVEYORS
ALSO
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Pitch, Creosote, Brick and Fuel Oils, Benzol, Solvent Naphtha, Sulphate of Ammonia.

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PINCHBECK'S Meters and Burglar PROOF STRONG BOX.
See illustrated advertisement, June 8, p. I. of Centre.
Pinchbeck Limited, Adams Place, George's Road, Holloway, N.

SPENCER'S PATENT HURDLE GRIDS.

THE very best Patent Grids for Holding Oxide Lightly.
See Illustrated Advertisement June 1, p. 559.

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Brotherton and Co., Ltd., Tar Distillers.
Works: Birmingham, Glasgow, Leeds, Liverpool, Wakefield, and Sunderland.

JOHN RILEY & SONS, Chemical Manufacturers, Hapton, near Accrington, are MAKERS of Special SULPHURIC ACID, for Sulphate of Ammonia Making. Highest percentage of Sulphate of Ammonia obtained from the use of this Vitriol, which has now been used for upwards of 50 Years. References given to Gas Companies.

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SULPHURIC ACID for Sale, specially suitable for making Sulphate of Ammonia.
Brotherton and Co., Ltd., Chemical Manufacturers, Works: Birmingham, Leeds, Wakefield, and Sunderland.

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LOWER MOSS LANE,
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For all Joints in connection with Oil-Gas Plant and Sulphate Plant.
For all Gas Joints.
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Represent the Strongest Independent Refineries in America; also Petroleum Spirit for Gas Enrichment. 18, Exchange Street, Manchester, and 11, Old Hall Street, Liverpool.

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Works: Oldbury, Wednesbury, and Stafford.
Address Correspondence and Inquiries to Oldbury, Worcs.
Telegrams: "Chemicals, Oldbury."

"GAZINE" (Registered in England and Abroad). A radical Solvent and Preventative of Naphthalene Deposits, and for the Automatic Cleaning of Mains and Services.
It is also used for the enrichment of Gas.
Manufactured and supplied by C. Bourne, West Moor Chemical Works, Killingworth, or through his Agent, F. J. Nicol, Pilgrim House, Newcastle-on-Tyne.
Telegrams: "Doric," Newcastle-on-Tyne. National Telephone No. 2497.

FIDDES-ALDREDGE
SIMULTANEOUS Discharging-Charger.
The one Machine which Discharges and Charges at One Stroke.
See Advertisement, May 4, p. II. of Centre.
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Telegrams: "Motorpathy, London." Telephone: 5118 Westminster.

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